The Effects of Age-Stereotyped Stimuli on Older People's Self-Perceptions of Age and Grip Strength.

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Abstract

Background: The psychology of ageing has shown that over time, changes in lifestyle and attitudes influence an individual's ageing experience (Deary et al. 2009). Recent statistics show that over 18% of the UK population are currently considered 'old' (Office of National Statistics, 2018), therefore it is becoming a priority that misconceptions and age-stereotypes relating to health and functioning during the ageing process are investigated to explore their possible affects. **Objectives:** The current thesis has 4 key aims, which are to: (1) Determine whether a natural association exists between functional health (as measured by grip strength) and self-perceptions of age in younger and older adults; (2) Develop a bespoke implicit age-stereotype priming task, which addresses 3 commonly cited limitations of previous literature, and present UK generated age-stereotyped word primes; (3) Investigate (using this improved method) the effects of negative, positive and neutral age-stereotyped word primes on younger and older adults' grip strength (GS) and self-perceptions of own ageing experience; and (4) Establish whether individual differences leave some older adults more vulnerable to the effects of age-stereotypes. **Method:** Participants were asked to self-report self-perceptions of age, to perform a simple grasping task to measure grip strength, and to complete an implicit age-stereotype word priming task. **Results:** Positive self-perceptions of age were positively correlated with higher GS amongst older adults only, independent of increasing older age. Exposure to negative age-stereotyped word primes significantly reduced both GS and self-perceptions of age in the older group only, whilst positive age-stereotyped word primes significantly increased GS. The former effect was significantly stronger than the latter. Mediation analysis confirmed that self-perceptions of age mediate the association between age-stereotyped word primes and GS. The age-stereotyped word primes acted as an intervention which either increased or decreased older adults' self-perceptions of age (depending on the valence of the prime words),

which in turn then either improved or weakened GS levels during the grasping task. Results also revealed that individual differences leave some older adults more vulnerable to the effects of age-stereotypes; those with lower self-perceptions of age are more vulnerable to the effects of negative ageing stereotyped word primes (experiencing significantly larger declines in GS), whilst also gaining the least benefit from positive age-stereotyped word primes (experiencing the smallest increase in GS). Cumulative analysis showed that those with lower self-perceptions of age also required exposure to a fewer number of implicit negative age-stereotype word primes to significantly reduce GS in comparison to those with higher self-perceptions of age (i.e., they are also vulnerable to the cumulative effects of negative age-stereotypes). Conversely, when those with lower self-perceptions of age were exposed to positive age-stereotype word primes, not only did they experience smaller improvements to GS, but importantly they also require exposure to more positive implicit age-stereotype word primes to improve GS in comparison to those with higher self-perceptions of age.

Discussion: I argue that the findings of this thesis are applicable to and informative for researchers, policy makers, and clinicians when attempting to identify those older adults most at risk of experiencing declines in functional health as a result of vulnerability to the effects of age-stereotypes. The current thesis findings also highlight approaches for early intervention in order to increase functional health through promotion of positive age-stereotypes.

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2.1 Introduction to the thesis

Natural ageing is the steady decline in bodily functions and cognitive ability over time. However, the term also includes stability and gains, which also accompany ageing. Light (1991) characterised ageing as having a mosaic pattern, which can bring with it both gains and losses in functioning. Natural ageing has also been depicted by some researchers as when an individual continues to be optimistic and contented when facing potential changes in their lifestyle as they age (Hill, 2005). Pathological ageing, in contrast, is defined as severe organic brain disorders, such as Alzheimer's disease, where individuals develop physical or cognitive disabilities early into the ageing process. The ageing process therefore includes a lot of individual variation, and as such, it could be conceived as occurring on a continuum where an individual can move back and forth between natural and pathological ageing in line with their lifestyle choices (Deary et al., 2009). Despite the distinction between natural and pathological ageing, many age-stereotypes focus only upon the pathological process, perpetuating the idea that the ageing process only includes sever irreversible decline, ignoring the cognitive growth, which can also complement the ageing process (Light 1991). For instance, recent research has highlighted that the birthday card market is a main culprit when perpetuating negative age stereotypes. From a sample of 150 birthday cards aimed at people aged between 40-100 years of age, the vast majority represented the ageing process in a stereotypically negative manner (Ellis & Morrison, 2005). This may be made even more salient by comparison with the media's representation of younger people, whose idealised representation often convey younger adults as displaying super strength and fitness.

One of the aims that gerontology (the scientific study of the process of ageing) and geriatrics (the branch of medicine investigating health and care of older adults) have in common is that they both investigate ageing and attempt to enable people to move further towards this natural spectrum by understanding more about the process of ageing, as well as lifestyle factors that influence this process (Pushkar, Andres, Arbuckle, Schwartzman, Chaikelson, 1999). Over time changes in lifestyle, education and attitude may influence how you move along the continuum between pathological and healthy ageing (Pushkar et al., 1999). This is of particular importance as the proportion of society considered to be older continues to increase. For instance, at present, over 18% of the UK population is considered as 'old' (Office of National Statistics, 2019). With this in mind, it is becoming a priority that misconceptions and stereotypes relating to health, functioning and cognitive ability, which surround the ageing process, are investigated to explore their possible affects.

This literature review will provide an overview of previous research investigating how negative and positive age-stereotypes operate, and whether and how they impact upon cognitive and physical functioning. Firstly, it will examine how ageing stereotypes are formed. Research highlights the fact that stereotypes relating to age can be formed from as early on as childhood (De Pallo, 1995). Secondly, the idea that ageing stereotypes can function under perceptual awareness will be evaluated. While most studies have focused upon the implicit operation of race or gender stereotypes, some studies have also examined implicit age stereotyping (Levy & Banaji, 2002). Thirdly, we will then move on to discuss how ageing stereotypes can become ageing self-stereotypes; often when people become older, the ageing stereotypes which were formed during the childhood years, which were internalized and reinforced through society, become self-stereotypes when an individual reaches an age they deem as 'old' (Snyder & Miene, 1994). The effects that these age-stereotypes can have upon

cognitive functioning will then be evaluated. In particular, this section will consider whether those cognitive declines associated with the ageing process can be, in part, attributed to psychological constructs such as ageing stereotypes. Following a review of cognitive literature, the focus will then turn to the much smaller body of literature which focuses on the effects of age-stereotypes on physical functioning. Research has indicated that writing speed, gait speed, balance, and general physical functioning can all be influenced by age stereotypes. Finally, this chapter will then outline the research objectives of the current thesis.

2.2 Age-Stereotype Literature Review

2.2.1 Formation and Internalization of Negative Age-Stereotypes

This section of the literature review considers research which discusses the formation of ageing stereotypes occurs at a relatively early stage in the ageing process (Seefeldt, Jantz, Galper, & Serock, 1977). This will be followed by a discussion of how ageing stereotypes can influence an individual's perception and their expectations of the ageing process.

Formation of age-stereotypes in childhood

Seefeldt et al, (1977) investigated the internalization and formation of ageing stereotypes in children. Their results found that stereotypes can create a negative perception of the ageing process from a very early age, as they are often formed from as young as 4 years old. The children in the study ranged from age 3 to 7 years old. They were each shown drawings that presented a man at four different ages in life. Results from the study highlighted that children from ages three and upwards could identify an old man from stereotypical drawings. Furthermore, 67% of the children reported that they viewed him to be incompetent of caring for himself and in need of help. Research by Burke (1981) produced consistent findings, demonstrating that children as young as 6 described these older adults as lonely, bored, and sad. These findings are not

surprising when you consider them in conjunction with the contexts from which children receive information about older adults. In children's story books, children are often presented with descriptions or images which depict older adults to be forgetful, mentally rigid, and being incapable and sleeping all day (Arluke & Levin, 1982; Cohen, 2000).

Burke (1981) also demonstrated that children's ratings showed that older adults were bypassed in preference for teachers or parents on descriptions of traits such as "knowledgeable." Not only do children form ageing stereotypes from a young age, but evidence has suggested that the internalization of such stereotypes may also influence their future expectations of what the ageing process is like. According to Seefeldt et al (1977), when the children were asked what they perceived growing old would be like, they reported that being old would be a purely negative experience. Responses of some children rated the ageing experience as 'awful.'

In summary, these studies show that stereotypes surrounding the ageing process and what it means to be characterised as 'old' are formed from as young as 4 years old (Seefeldt, et al, 1977).

2.3 Internalization and operation of age-stereotypes

The internalisation of negative ageing stereotypes is often facilitated by an increased exposure to ageing stereotypes from a number of different sources (Hausdorff, Hencke, & Wei, 2000). For instance, research into the representation of older adults within television shows and TV adverts highlight that older adults feel that they are not accurately represented in the roles created by media producers (Milner, Milner, & Van Norman, 2012). Research by Pickett (2002) has demonstrated that older adults report believing themselves to be under-represented in the media and that they are presented in a negative manner. Pickett (2002) also highlighted that 75% of adults over the age of 55 report dissatisfaction with marketing aimed at them, with 71% reporting that images of

older adults in the media do not accurately depict their lives. A study by Age UK in 2009 reported that 55% of adults over the age of 50 years believe businesses pay little interest to the needs of older consumers, and that 50% of older adults find the marketing of products which are obviously aimed at older people to be patronizing and stereotypical. These statistics, and the aforementioned research, highlight that these misrepresentations of older adults, portrayed through the media, could serve to reinforce and internalize negative age-stereotypes. This is of particular importance because older adults aged over 65+ years are reported to spend three times more of their waking hours watching both live and time shifted television (e.g., online TV services, such as Netflix) in comparison to younger adults; totalling 7.24 hours per day (The Neilson Total Audience Report, 2018). In addition to this, Levy and Banaji (2002) have already noted that by the time an individual reaches old age, they have already spent in excess of 50 years expressing and internalizing negative age-stereotypes.

Recent advances in online TV streaming platforms has brought with it access to a much wider selection of TV shows, and as such, recent independently funded shows such as Grace and Frankie, have started to represent the lives of older adults in more accurate light. That in particular highlights the valuable contribution older adults make to society and the economy. Whilst this one particular show may depict a more accurate representation of older age, recent research has demonstrated that negative age-stereotypes are still thriving in primetime and online TV shows. A recent report by Smith, Pieper & Choueiti (2015) revealed that within a sample of 72 shows in which the primary demographic watching were older adults over the age of 60 years, only 39 shows included one older adult character. Of these 39 shows, 41% included one of more ageist comments. Shows without a 60-plus writer were more likely to feature an ageist comment than shows with senior writers; 81.2% of TV shows with ageist comments were written by a writer younger than 60 years of age.

What is also interesting from this analysis is that it revealed that only 20% of the main older adult characters in TV shows were depicted as using any form of social media or online platform. This is severely misrepresentative of the actual number of older adults who do engage with social media. For instance, the Central Bureau of Statistics (2017) has shown a dramatic rise in older adults engaging with social media within the last 5 years, with 64% of older adults reporting regular use of social media sites such as Facebook, WhatsApp and Netflix, and 34% of these being over the age of 75 years.

This continued misrepresentation of older adults is unfortunate, because with these increased numbers of older adults successfully using social media outlets (such as Facebook and Netflix), this could create a new opportunity to harness the voices of older adults and involve them more directly in the life of younger adults. Ultimately, this would make older adults more relatable to younger adults, and potentially reduce the occurrence of ageism.

Unfortunately, as a result of increased exposure to these negative media messages throughout the life span, negative age-stereotypes can become ingrained in an individual's perception of the ageing process, creating the perception that the ageing process is a wholly negative experience, associated only with decline (Levy et al., 2002). It appears that, within middle-aged adults, there is also a high level of vulnerability to these negative age-stereotypes. This is in part because these stereotypes refer to older adults, who, during middle age, are seen as the 'out group,' and as such, there is no psychological need to defend against these stereotypes (Levy & Banaji, 2002). Stereotypes are further internalised within individuals by a number of different cognitive processes. After such a long-time period of internalising and expressing negative stereotypes about ageing, it is logical to assume that the stereotypes that older

adults hold about their own social group are very similar to those which the rest of society hold.

It appears that when perceiving older adults, ageing stereotypes are dominant in comparison to our experiences with them. Often when adults are asked to recall information regarding an older adult, they recall information that is consistent with ageing stereotypes (Levy, 1996). Research highlights that this occurs in numerous social situations when interacting directly with older adults. For example, although the issue of cognitive decline with ageing is complex, involving both cognitive decline and growth, and with variation between individuals, large proportions of society still perceive older adults as using less sophisticated grammar (Emry, 1986), being overly repetitive (Gold, Arbuckle, and Andres 1994), and talking more slowly (Stewart and Ryan 1982). In the working environment, despite younger colleagues often having regular contact with older workers, they often rely on inaccurate stereotypes in their perceptions of older colleagues. Younger workers tend to report older colleagues as less productive and making fewer valuable contributions to the team (Mcann & Giles, 2002). This is particularly relevant as 25% of companies cite 'the mental demands of the job' as a factor which influences their decisions of hiring or retaining a staff member over the age of 55 years (Mirvis, 1993). While there is no denying that cognitive decline does occur with age, there is much variation in the rate and extent of cognitive decline (Deary, Whalley, Lemmon & Crawford, 2000), and age-stereotypes that do not accurately reflect the abilities of a large proportion of older adults can create a disconnect between individual's perceptions of an older adults cognitive capabilities and their actual ability (Mirvis, 1993). Should individuals encounter an older adult who does not fit with these stereotypical expectations, in order to correct this dissonance, these older adults are considered to be an exception to this already internalised category of older adults (Levy et al., 2002), and are not recalled as readily as the stereotypical examples.

In summary, media sources (from advertising and TV outlets to online media) often portray older adults in a patronising and stereotypical light based on negative perceptions of ageing (Smith et al, 2015). Repeated exposure to these negative age-stereotype messages throughout the life span can become engrained in individuals (Levy et al, 2002), creating the perception that the ageing process is wholly a negative experience, associated only with decline (Levy et al., 2002) and ultimately creating a disconnect between an older adults' perceptions of their abilities and their actual ability. The following section will now move on to discuss how the expression of negative age-stereotypes throughout the lifespan can become self-stereotypes in older age, which influence not only how we perceive our abilities in old age but also our behaviour.

2.4 Age-stereotypes become self-stereotypes in older adults.

Age-stereotypes are different from gender, race and many other forms of stereotypes for one primary reason. As individuals age, the ageing stereotypes formed and internalized during childhood, which further become reinforced in the adult years through repeated exposure to anti-ageing and negative age-stereotypical messages can actually develop into self-stereotypes (Snyder & Miene, 1994). This section of the literature review will consider how negative ageing self-stereotypes are formed amongst older adults, discussing two stages to this formation of age-related self-stereotypes.

2.4.1 The formation of age-related self-stereotypes

Research has suggested that age-related self-stereotypes are formed in two phases. Phase one of age-related self-stereotypes represent an artificial definition of 'old' that is imposed upon an individual, rather than a term that the individual has accepted (Sherif, 1953). This occurs when an individual reaches an age that is considered as old either by being perceived as 'old' by other people, or by reaching an age that establishments often consider to be 'old.' During this phase, ageing stereotypes develop into ageing self-stereotypes because these stereotypes are no longer targeted at

out-groups; instead they target individuals who are categorised as belonging to one's own membership group (Tajfel, 1981). The second phase involves an individual accepting their membership within the 'aged' membership group (Hyman, 1942). How long it takes someone to identify with the reference group of 'old' is suggested to be dependent upon the negativity of the ageing stereotypes that the individual endorses. For example, an individual who endorses more negative ageing stereotypes will be more reluctant to identify with similar older adults (Levy & Banaji, 2002). This would be demonstrated in denial behaviours, such as the use of remedies to fight the signs of ageing like Botox injections, which provide a relatively short delay in the formation of wrinkles (Finn, 2002).

While it is possible for individuals to 'fight' the ageing process, the barrier that denial can provide to reduce the relevance of ageing stereotypes for oneself is likely to 'break down' through the persistent and repeated reminders of an individual's agedness that are present e.g., through advertising and TV and online media in daily life (United States Senate Special Committee on Ageing, 2002). As a result, it would be expected that, as individuals grow older, their identification with their own cohort will also directly increase. Hummert et al. (2002) have demonstrated that this is exactly the case. Older adults aged 55-74 reported associating themselves and identifying more with younger adults, compared with those who were over 75 years of age, who, in contrast, were more likely to identify themselves with individuals of their same age.

To summarise, age-stereotypes become self-stereotypes via a two-step process in which, firstly, the label of 'old' is imposed on an individual often when an individual reaches an age that is considered as old either by being perceived as 'old' by other people, or by reaching an age that establishments often consider to be 'old.' During step 2, over time, an individual will begin to accept their membership within the 'old' membership group (Hyman, 1942). How long this process takes will depend on how

negative an individual's perceptions of being 'old' are. I will now move on to the next section to consider whether older adults show in-group preference after accepting their membership identity.

2.5 Do older adults show an in-group preference?

What is clear and important from the research investigating self-stereotypes in older adults is that in-group preference does not occur among older adults (Nosek & Banaji, 2002). Often older adults exhibit attitudes towards other older people that are considered to be as negative as those which can be expressed by younger people. Studies that examine the attitudes expressed by younger and older adults highlight that there is a strong degree of similarity between the two. This means that older adults express attitudes towards other older people that are equally negative to the attitudes expressed by younger adults. The idea that in-group preference does not occur within older adults is further evidenced by research that considers decisions over funding for programmes aimed at helping older people. In a sample of participants, which was selected nationally, the older participant's demonstrated stronger objections opposing spending on government programmes that could benefit their needs, such as meals on wheels and Medicare. What was most interesting from the analysis of these results is that the degree of opposition expressed by older adults was significantly stronger than that reported by the younger participants. Furthermore, the degree of opposition posed by older people was predicted by their endorsement of ageing stereotypes. Ultimately, these results highlight that a more positive attitude and preference towards those within a group membership category typically does not happen amongst older adults.

2.5.1 Age-stereotypes operating without awareness

Unfortunately, ageism in the western world appears to be alive and well. In recent years, 84% of Americans reported at least one incidence of ageism, with 50% reporting multiple incidents (Ory, 2003). Moreover, it would appear that these incidents

of ageism often go undetected in real life environments due to their subtle nature. For instance, older adults reported receiving birthday cards that made fun of older people, and in fact many older adults failed to recognise these as a form of negative age stereotyping (Ellis & Morrison, 2005). In response to the growing concern over ageism and how it may operate, an array of research studies has considered the unconscious operation of stereotypes, with a number of these examining the unconscious operation of ageing stereotypes in particular. Priming is a technique often used in age-stereotype research studies, during which a task is used to activate or 'prime' particular associations within our memory, just before performing a task. In age-stereotype research, this often involves activating associations we have created (across the lifespan) which connect old age with inevitable decline. Perdue and Gurtman (1990) were one of the first to investigate how ageing stereotypes operate using priming techniques. Their research highlighted that there was an automatic cognitive element involved in associating negative traits with age. During the study, college students were subliminally primed with words such as 'old' or 'young' during a computer-based word search task. After the subliminal ageing primes, one of the 18 positive and 18 negative traits were shown on a television screen. Participants were then asked to decide whether they thought it was a good or bad trait to possess. Results indicated that when the participants received primes which included the word 'old,' they judged a person's traits more negatively and these decisions were made significantly faster compared to performance after being subliminally primed with words such as 'young.' The results of the study suggest that this may be due to participants cognitively categorising a person into the category 'old,' and this then creates a small group of similar, mostly negative constructs, which can be readily accessed and are drawn on when making judgements about a specific person. As a result, it is likely that the individual will display signs of ageism right from the beginning of any perception processes- which are often employed

in daily living while an individual socially interacts with someone. For example, when a younger adult is conversing with an older adult, they may slow their speech or talk in a louder manner, as they have categorised 'old' with negative constructs such as deaf, or reduced ability to understand information.

Previous research has shown that age-stereotypes can function both above and below an individual's level of conscious awareness, but crucially, that older adults can report implicit and explicit beliefs about ageing that drastically differ from one another. For example, Nosek (2002) conducted a review which considered the relationship between explicit beliefs (that are conscious, often self-reported) and implicit beliefs (that are at the unconscious level, and often these are biases which we are not aware of). Results highlighted that explicit and implicit beliefs about ageing were shown to have the smallest correlation, demonstrating that while it is possible for an individual to outwardly express a positive attitude towards being older, they may actually also hold internal biases (implicit beliefs), which are negative representations of older age (Nosek et al, 2002).

To sum up, age-stereotypes can be formed from as young as 6 years old (Seefeldt et al., 1997), and over time, due to repeated exposure throughout the lifespan, these age-stereotypes can become ingrained in individuals as adults. Adults often carry these age-stereotypes with them into older age to the extent that they self-stereotype and no longer demonstrate an in-group preference (Nosek et al, 2002). In addition, not only can stereotypes operate below an individual's level of conscious awareness (on an implicit level), it is also clear that age-stereotypes can operate at explicit levels (Nosek et al, 2002). This suggests that an individual can hold implicit negative beliefs about the ageing process while explicitly expressing positive beliefs about ageing as implicit, and explicit beliefs are considered to operate independently of one another (Nosek et al, 2002). As the population continues to age, with people over the age of 60 years now

representing more than 18% of the UK population (Office of National Statistics, 2009), it is important to consider what the possible impact of age-stereotypes may be upon the health, cognitive functioning and motor control of older adults. The following section of this literature review will move on to consider the impact of age-stereotypes upon the health and general functioning of older adults.

2.6 Impact of age-stereotypes on health and general well-being

Previously, I reviewed evidence that supported the concept that age-stereotypes formed in childhood and adulthood can become self-stereotypes for older adults in the later years of the lifespan and can operate below an individual's level of conscious awareness. Building upon this concept, a recent trend is emerging from current research demonstrating that both negative age-stereotypes and the self-expectations they create can have serious implications for the health decisions and health behaviours that older adults do or do not engage in. For instance, it has been suggested that older adults who endorse a more negative view of the ageing process take poorer care of their health. The Ohio Longitudinal Study of Ageing (Levy & Myers, 2004) investigated the association between older adult's health behaviours and their self-perceptions about ageing. The project investigated whether positive or negative age self-perceptions could predict a wide range of self-reported health behaviours, such as: regular GP visits, maintaining a balanced diet, medication compliance, participating in regular exercise, refraining from smoking tobacco products, and regularly wearing a seat belt whilst in the car. Results from the study highlighted that over the next twenty years, those older adults who endorsed significantly more positive self-perceptions about being 'older' were more likely to engage in more preventative health behaviours, including getting regular exercise and maintaining a healthy diet whilst avoiding tobacco products and complying with medication schedules.

It is clear that the implications of age-stereotypes go far beyond purely self-reported health measures, with recent research indicating that age-stereotypes can also influence older adult's sensory perception. For example, following the trend investigating how age-stereotypes can influence general health in older adults, Levy, Slade, and Gill (2000) investigated whether the age-stereotypes endorsed by older adults could predict hearing loss. Results show that those older adults who endorsed more implicit negative age-stereotypes and who also demonstrated signs of endorsing external negative age-stereotypes, such as poorer physical appearance, performed worse on hearing assessments 3 months after an initial hearing baseline measurement was taken, independent of expected age-related decline during this period. In addition, structural equation modelling suggests that the level of hearing decline these participants experienced over the 3-month time frame was equivalent to the increase experienced by those reporting more positive implicit age-stereotypes experience over an 8-year period. One possible explanation for this effect could be that negative age-stereotypes increase the likelihood of older adults simply accepting hearing loss as an inevitable part of the ageing process. For instance, in comparison to younger adults, older adults are more likely to simply accept hearing loss as inevitable as we get older (Fozard & Gordon-Salant, 2001), and are less likely to seek out medical care in search for any possible hearing interventions (Yueh et al., 2003). A factor that could further compound the belief that hearing loss is inevitable as we get older could be the lack of support to find hearing interventions offered by friends, family and health professionals – who may also endorse negative age-stereotypes and subsequently believe that hearing loss is inevitable with age (Mahoney, Stephens, & Cadge, 1996).

It is possible to conceptualise the effects of age-stereotypes upon older adults' healthcare experiences as a two-sided coin. On one side, older adults who endorse more negative age-stereotypes are less likely to engage or seek out health professions in

response to general decline. On the other, age-stereotypes can often influence the medical attention older adults receive from healthcare workers, as this also appears to be influenced by popular age stereotypes. Ory (2003) has noted that doctors are less likely to administer aggressive medical treatment to older adults – regardless of whether they are healthy or strong enough to cope with the treatment. Moreover, Ory also suggests that ageist attitudes held by doctors and other health care professionals are a barrier to successful and effective communication between health care workers and patients. As a result of this poor communication, it is possible for older adults to receive suboptimal healthcare treatment.

In addition to possibly receiving suboptimal healthcare treatment, for older adults the impact of negative age-stereotypes perpetuated by society is likely to be two-fold, as exposure to negative age-stereotypes is also likely to increase cardiovascular stress (Levy, Hausdorf, Hencke & Wei, 2000). Research indicates that increased cardiovascular stress can have a detrimental effect on overall health outcomes as chronic stressors and has previously been linked to the early development of heart disease (Barnett et al., 1997). Levy et al. (2000) investigated the effect of both negative and positive implicit age-stereotype primes upon cardiovascular stress levels of older adults before and after completing mathematical and verbal reasoning tasks. Participants were allocated to either a positive or negative age stereotype priming condition, where positive or negative age stereotype words appeared upon a screen at speeds below each participant's level of conscious awareness. In real life, exposure to age-stereotypes and stressful tasks is likely to re-occur at several points within an average day. In order to more closely resemble this, the stressor tasks and the age-stereotypes that older adults are likely to encounter in real life, the study was designed so that each participant would complete two sets of negative or positive age-stereotype primes and two sets of mathematical or verbal challenges with a break in between each. Baseline physiological

responses were taken before exposure to any stressor task or age-stereotyped primes. These were then re-measured after completing the first priming condition and the first set of mathematical and verbal tasks, then again after the second set of age stereotype primes and second set of mathematical and verbal tasks. Results conclude that for those participants who experienced the negative age-stereotyped primes, compared to baseline measures, skin conductance, systolic and diastolic blood pressure, increased significantly after completing the first negative age-stereotyped prime condition and the first set of mathematical and verbal reasoning tasks. However, after this initial increase, while all cardiovascular measures remained heightened, there was no further significant increase in cardiovascular stress after the second set of age stereotype primes, or the second mathematical and verbal tasks. What is interesting about the pattern of results is that the effect of the negative age stereotype primes appeared to happen immediately after completing the first set of primes, and this immediate increase in systolic, diastolic blood pressure and skin conductance lasted for as long as 26 minutes after completing the priming intervention. This is a significant amount of time to experience increased blood pressure on a day-to-day basis after coming into contact with age stereotypes.

Results also indicate an interesting pattern for those participants who experienced the positive age stereotype primes. In contrast to the immediate effect of the negative age stereotype primes, for those placed in the positive prime condition, it appears that the first set of positive ageing stereotypes did not immediately protect participants from the stress of completing verbal or mathematical tasks. Instead, results demonstrated a significant increase in their cardiovascular stress measures occurred after the first set of mathematical and verbal challenges. However, a significant decline in systolic, diastolic blood pressure and skin conductance occurred after the second set of positive age stereotype primes, suggesting that the positive age-stereotypes not only protected measures of cardiovascular stress in the second set of verbal and mathematical

challenges, but the positive age-stereotypes also appeared to help older adults to recover from the earlier stressors in the first task. Ultimately, it appears that the positive age-stereotypes required more exposure to elicit a change in older adults' cardiovascular stress levels. This would indicate that, while negative age-stereotypes have an immediate effect on increasing cardiovascular stress, positive age-stereotypes, on the other hand, have a cumulative effect while decreasing cardiovascular stress. This point is particularly interesting; to date, while numerous studies have used a similar priming paradigm to the one used by Levy et al (2000), and have also found similar effects of positive and negative age-stereotypes upon cognitive as well as physical abilities, no study has examined cumulative effects in age stereotype primes. This means little is known about how these stereotypes illicit a change in participant's performance.

In summary, it is evident that the age-stereotypes that are widely endorsed by society and healthcare workers can have both positive and detrimental effects upon the general health of older adults. In particular, research by Levy et al (2004) highlights that addressing the views that people of all ages have regarding the ageing process could help to improve the long-term efforts within older adults to take more preventative health measures and engage in maintaining a healthier lifestyle in the later years of the lifespan. Moreover, if society's view towards the ageing process remain negative, there is a clear link between endorsing negative age-stereotypes and poorer general health behaviours, as well as poorer general health. In an attempt to integrate the results of all of the studies discussed in this section, it is possible that the impact of age-stereotypes could form a vicious circle of affects. For instance, if older adults regularly come into contact with ageing stereotypes or stereotypical attitudes from those they interact with on a societal level (or also in various forms of print, visual, and auditory media) it is likely to cause a momentary decline in numerous abilities (processes which occur without the need for an individual's attention or awareness). It is also likely to increase

cardiovascular stress (Levy et al., 2000), which in turn can cause further adverse effects on their health, which in turn increases their need to interact with healthcare professionals and seek medical attention. As some healthcare professionals have also been highlighted to use age-stereotypes when making healthcare treatment decisions, it is likely that some older adults will often receive suboptimal healthcare. In a review that considered the effects of ageism upon cardiovascular disease, Bowling once noted that ageism within the clinical fields of medicine more often than not reflects the ageism that is evident in wider society (Bowling, 1999, p1353).

While the current section discussed the effects of age-stereotypes upon general health, the following section will focus more specifically upon the effects of age-stereotypes upon the cognitive abilities of older adults.

2.7 Impact of Age-stereotypes on cognitive abilities

Research has shown that negative stereotypes can adversely influence performance on a number of cognitive tasks for a number of different minority groups – such as women and African Americans, to name just a few. Throughout the last 20 years, a large proportion of the age-stereotype research has focussed exclusively upon the effects of age-stereotypes on older adults cognitive functioning, with less of a focus on considering physical ability.

Numerous studies have consistently demonstrated that negative ageing stereotypes are correlated with decreased perceptions of future functioning, and experimental studies have consistently shown that negative age-stereotypes can reduce the cognitive ability of older adults. Moreover, previous research has suggested that tasks measuring memory and automatic processing (processes which occur without the need for an individual's attention or awareness) in older adults are most likely to be adversely affected by implicit negative age-stereotypes (Aisenberg, Cohen, Pick, Tressman, Rappaport, Shenberg, & Henik, 2015). Conversely, a similar stream of

research has also highlighted that while negative age-stereotypes can reduce cognitive functioning, positive age-stereotypes can have a significant impact upon improving cognitive functions of older adults. This section aims to critically review evidence that suggests negative and positive beliefs, or age stereotypes, held about the ageing process can influence cognitive functioning in older adults.

2.7.1 Culture, implicit age-stereotypes, and memory

An Initial study conducted by Levy and Langer (1994) investigated whether culture and age-stereotypes were linked to one another, and how this might reflect in the performance of working memory and spatial processing. The study incorporated young and old participants who were from a mainland Chinese background, deaf American background, as well as mainstream American participants. The Chinese and deaf American populations were used as comparison groups to the mainstream Americans, as culturally, these two populations typically display a more positive attitude towards the ageing process. Analyses indicated that Chinese participants reported the most positive views towards the ageing process, with American deaf participants reporting the second most positive views of the ageing process, and the mainstream American hearing participants demonstrated the least positive view. Results showed that the participants' memory performance reflected this pattern of attitudes towards the ageing process. The Chinese participants performed significantly better at memory tasks, followed by the deaf Americans, and finally the mainstream American hearing participants performed the poorest. Additionally, this pattern of results was only found in older adults, and was not found in the younger mainland Chinese, American deaf, or American hearing participants. These results suggest that different cultures and attitudes towards the ageing process are associated with different performances in the memory ability of older adults. This pattern of results supports the stance that memory functionality is not only influenced by biological process, but also psycho-social factors,

such as attitudes towards aging, which are also important in moderating age-related memory decline (Yoon, Feinburg, Hasher, Rahhal, & Winocur, 2000). From these results, however, it is not clear if those older adults who showed more significant levels of decline expressed more negative ageing stereotypes.

Following this trend, research has moved a step forward to experimental investigation of whether ageing self-stereotypes influence memory abilities, or if increased memory ability is affected by self-stereotypes of ageing. Levy (1996) investigated the effects that implicit age-stereotyped priming could have upon not only older adult's memory abilities, but also upon their attitudes and expectations of the ageing process. Levy measured the effects of priming upon 6 different memory tasks: immediate recall, learned and delayed recall, photo recall, auditory recall, and metamemory. In addition to measuring memory, in order to assess both changes in stereotype endorsement and longer held beliefs about ageing, Levy developed a short target story detailing an old lady protagonist, which was followed by a set of questions which measured participant's views towards older adults. This story task was modelled after a similar task used by Benaji et al., (1993). During the study, older adults were exposed to negative and positive age-stereotype word primes. This consisted of a short video where positive and negatively valanced words associated with ageing (such as 'wise' or 'Alzheimer's' respectively) were flashed on a screen. Words were flashed at speeds (for durations) that were designed specifically to allow participants to perceive a flash but remain unable to consciously perceive the words being flashed.

Results demonstrated that, on average, those older adults exposed to the negative ageing stereotypes performed significantly poorer on four different memory tasks. In contrast, for those older adults exposed to the positive ageing primes, performance on the same 4 memory tasks significantly increased. In particular, results indicated that performance on the immediate, learned recall, delayed recall, and the photo recall tasks

were most susceptible to the effects of both the positive and negative age-stereotypes word primes. It also appears that age-stereotyped word primes may at least have a short-term effect upon the memory functioning of older adults, as the effects remained significant even for those who experienced a twenty-minute delay after completing the priming task but before re-completing the memory tasks. Finally, results also indicate that if age stereotype primes are to change a self-stereotype of ageing, they must hold personally relevant material. For instance, the age priming effects of the age stereotype words only affected performance on the memory tasks for older adults and did not significantly affect the younger adult's performance. More specifically, results also indicate that the effects of the priming intervention were as strong for those age between 60-72 years old as it was for those aged between 73-90 years old. This means that increasing age within the older adult's group does not seem to strengthen the effect or make these individuals more vulnerable to the stereotype effects. Rather, a participant simply only needs to identify with the social group 'old' in order for the stereotype prime to become personally relevant and elicit a change in memory performance.

Difficulties in replicating similar priming effects to those found by Levy (1996) are a commonly cited criticism of age stereotype priming literature (Horton, Baker & Deakin, 2007; Horton, Baker, Pearce, Deakin, 2010). Evaluation of the methods used suggests that this could be because of key methodological limitations. For example, the effects of the prime depend on whether the priming method is successful in operating below participants' level of conscious awareness (which requires not being able to perceive the word when it is flashed on the screen). This is illustrated by a number of studies which have partially replicated priming effects upon photo recall and dot location tasks. For example, Stein, Blanchard-Fields, and Hertzog (2002) measured the effects of age stereotype priming on dot location and photo recall tasks. The authors adopted a similar priming paradigm to that used in Levy's original 1996 paper (i.e., they

used an implicit priming paradigm). While results from Stein and colleagues' paper demonstrates that older adults exposed to negative age-stereotypes did perform significantly poorer on photo recall and dot location tasks compared to baseline measures or performance, they did not find a significant improvement in performance for those exposed to positive age-stereotype primes. The authors highlight that participants memory performance on both the dot location and photo recall task were only influenced by the primes where the participants were 'unaware' of the content of the ageing primes (i.e., could perceive a flash but not read the word). For those participants who reported perceiving the primes and were considered to be 'aware' of the primes (i.e., were able to perceive the flash and read the word), there was no significant effect of the priming condition upon task performance. Participant feedback revealed that the participants were able to read a higher number of the positive age-stereotyped word primes than the negative age-stereotyped word primes, however, the researchers gave no possible explanation for this. Whilst the researchers provide no explanation for this, one possible reason could be that the age-stereotype priming task did not account for the wide variation in individual's visual processing speeds, which are known to increase with age (Wiegand, Töllner, Dyrholm, Müller, Bundesen, & Finke, 2014), as the prime presentation speed (i.e., length of time the word appeared on the screen for) was not tailored to the individuals visual processing speed.

These findings (or lack thereof a significant result) highlight the importance of carefully designing the priming paradigms, with particular attention paid to how long the age-stereotyped words should be flashed on the screen for (referred to in the literature as 'speed' of presentation), in order to account for individual variation in participants' visual processing speeds. In order for implicit age stereotype primes to activate ageing self-stereotypes, it is important that they operate below the participants level of conscious awareness (Levy, 1996). Therefore, it appears vital that the priming

paradigm employed by researchers accounts for individual differences in visual processing speeds. I.e., some participants may require shorter presentation speeds than others (Wiegand et al, 2014).

In summary, combining the findings from the papers reviewed above, overall the results do demonstrate a strong trend that negative age-stereotypes, and in particular those which depict older adults to be senile, are associated with reduced levels of cognitive functioning, particularly on memory tasks. These findings, combined with other previous research (Levy, 1996) that shows ageing stereotypes to operate on an implicit level, suggest that older adults' memory abilities can decline further through exposure to negative ageing stereotypes, and that this process may go undetected. While research that uses an implicit age-stereotyped priming paradigm demonstrates that age-stereotypes can operate in a subtle manner, further research also suggests that direct and consciously perceived positive and negative age-stereotypes can in some cases elicit a 'stereotype threat' effect (Hess et al., 2003), which in turn causes similar effects upon cognitive functioning in older adults. Cognitive functioning is an important ability that older adults rely upon when not only processing information but when making decisions in real world scenarios. The following section will move on to discuss how age-stereotypes can influence the decision-making process of both younger and older adults.

2.8 Age-stereotypes and decision-making processes

Earlier in this literature review, I reviewed evidence that suggests some health professionals overly rely upon age-stereotypes when making healthcare decisions regarding treatments for older adults, often opting to not provide aggressive treatments regardless of whether or not the older patient was strong enough to complete the treatment (Ory et al., 2003). A study by Levy, Ashman and Dror (2000) suggests that additionally, age-stereotypes can also influence older individual's decision-making processes; in particular, healthcare decisions. Using the priming paradigm previously

established by Levy et al., (1996), 64 older adults were firstly subliminally primed with either positive, negative or neutral age stereotypical words. Following this priming paradigm, participants were presented with hypothetical medical situations, all of which included the participant having a fatal illness, with numerous treatment options, one of which would prolong their life. Each scenario included details of any disadvantages to the treatment, i.e., the treatments being 'time heavy' as family members would be required to spend a lot of time administering treatments and monitoring progress or any financial costs related to the treatment. Results of the study reported that, regardless of the cost of the intervention in terms of both time and money, those older adults who had been exposed to positive ageing stereotypes displayed a trend to accept interventions to prolong their life. In contrast, those who were exposed to the negative ageing stereotypes showed trends to refuse treatments which could potentially prolong their life. These findings demonstrate that the impact of age-stereotypes doesn't exclusively apply to memory, but also, they influence the decision-making processes of older people.

More recent research has since replicated this original study, using a Portuguese sample of participants (Marques, Lima, Abrams, & Swift, 2014). Again, the will to live in older and younger participants was measured using healthcare scenarios, before and after a priming intervention where common Portuguese age-stereotypes were presented on a screen, followed by backwards visual masks. Additionally, in order to examine the persistence of age-stereotypes upon decision-making processes, the study also incorporated 'delay' and 'no delay' conditions. Participants in the 'no delay' condition re-completed the will to live scenarios immediately after the priming paradigm, whilst those placed in the 'delay' condition were asked to perform a 'distraction task' (backwards digit span task) for 3 minutes after completing the priming paradigm, but before recompleting the will to live scenario. Results of this study replicated those

found in Levy's initial study investigating older adults will to live (Levy et al., 2000). Those participants who were placed in the negative age stereotype prime condition showed a trend to refuse life-prolonging treatments. While on the other hand those participants who received positive age stereotype primes showed a trend to accept life-prolonging treatments. Interestingly, the effect of the age stereotype primes remained significant in the 'delay' condition for both the positive and negative age-stereotype primes, highlighting that the effects of the age stereotype priming could have a longer lasting effect on older adults' engagement with life-prolonging medical decisions. Age stereotype priming literature has come under criticism in recent years due to a failure to widely replicate any priming effects (Doyen, Klein, Pichon, & Cleeremans, 2012) and also for failing to consider the multiple contextual constraints that are likely to be present when older adults encounter age-stereotypes in day-to-day environments (Bargh, 2006). The finding by Marques et al., (2014), that age stereotype priming effects remained significant after a distractor task and a time delay, provide compelling evidence that the activation of unconscious stereotypes do in fact affect older people's decision making and behaviour in more complex real-life situations. Additionally, current literature on health care decision-making processes in older adults demonstrates that older adults are more likely to engage heuristic modes of processing in order to make considerably quicker health care decisions than younger adults do (Liu & Gonzalez, 2007). There are a number of reasons why older adults may make quicker healthcare decisions. These health decisions may demand more cognitive resources, creating a 'supply and demand' issue, resulting in older adults relying upon heuristics to sway their decision-making (Park et al., 1996; Salthouse & Babcock, 1991). Alternatively, life experience and a greater knowledge regarding their own health may allow older adults to make a decision on the matter significantly quicker than their younger counter parts (Klein, 1997). Whatever the reason may be, the finding that age-

stereotypes continue to influence healthcare decisions in older adults after a time delay of 3 minutes has important implications. For instance, even if an older adult does not make an instant decision after a question is posed by their doctor, the majority of healthcare decisions must be made within the time frame of a single appointment – which in the UK currently stands at a maximum of 12 minutes per patient (British Medical Association, 2014). Therefore, it is likely that health care decisions made within a single appointment time frame are in fact susceptible to the influence of subliminal aging stereotypes, such as those conveyed by the doctor's attitude and use of language, which may have negative ageing connotations.

To summarise, it is clear that numerous studies have demonstrated that exposure to both implicit and explicit negative ageing stereotypes is associated with a decrease in performance on both memory tasks (Stein, Blanchard-Field, Hertzog, 2002) and inhibitory processing skills. While conversely, exposure to positive implicit and explicit ageing stereotypes is associated with significant increases in performance on the same memory and inhibitory processing skills. With this in mind, it is regrettable that the media persists in the promoting of negative age-stereotypes and largely ignores the positive aspects of the ageing process. In addition to influencing cognitive functions, it also appears that age-stereotypes influence the healthcare decisions that older adults are faced with making as they grow older, with those experiencing negative age-stereotypes displaying a trend to refuse life prolonging treatments. Importantly, the effects of ageing stereotypes upon cognitive functioning and the decision-making process appear to last longer than what can be considered as momentary by many critics, with results demonstrating the effects of age-stereotypes can last for up to 20 minutes after exposure. The following section of this literature review will move on to discuss the effects of age-stereotypes upon older adult's self-perceptions of their own ageing experience.

2.9 Impact of age-stereotypes on physical functioning

While negative and positive age-stereotypes exist in many western cultures (Löckenhoff et al., 2009), the negative age-stereotypes are more prevalent and often perpetuated by many media outlets. These tend to exaggerate the amount of physical decline that many older adults experience as they grow older, perpetuating negative age-stereotypes towards physical functionality. This can have serious implications as recent research has highlighted there is an important link between physical activity in older age and increased general health (Ory, Hoffman, Hawkins, Sanner, & Mockenhaupt, 2003). Despite this, public health statistics have highlighted that in the western world, only 13% of women and 22% of males actually reach the required levels of physical activity to gain any health benefits (Statistics Canada, 2005). Yet, when polled, 98% of adults aged 50+ years reported that they believed remaining physically active was important in order to stay healthy (Ory et al, 2003). This disconnect between what older adults know to be important in maintaining health and their actual health behaviours is concerning given that a lack of physical activity is believed to be one of the main contributing factors in functional decline in older adults (Maharam, Bauman, Kalman, Skolnik, & Perle, 1999). Secondly, this disconnect also raises the concern as to how much of the decline associated with growing older is actually the result of inevitable biological decline, and how much of this decline can be attributed to the role of psychosocial factors? Attitudes towards ageing, particularly negative age-stereotypes that are prevalent in western societies, are a potentially important barrier in reducing the number of older adults who remain physically active into older age (Levy et al., 2004). At present though, a large proportion of age-stereotype research has focussed on how these can affect cognitive functioning, paying particular focus to memory. There is a much smaller and more varied literature considering how age-stereotypes influence physical functioning and perceptuo-motor control.

This section will discuss age stereotype research that has demonstrated the effects of both positive and negative age-stereotypes upon physical activity and functionality in older age.

2.9.1 Stereotype threat and physical function

While research has shown a decline in physical performance as we age (Porter, Vandervoot, & Lexell, 1995), debate remains as to what extent of this decline is the result of inevitable biological processes or numerous psychosocial factors such as age-stereotypes.

Research has indicated that while grip strength declines by 50% after the age of 75+ years, individuals experience the vast majority of decline in grip strength after the age of 50 years. While grip strength is considered to require very little skill, it is often considered as a key marker of functional health in older adults and is indicative of their ability to perform everyday action tasks, e.g., opening jars, writing, carrying shopping bags. In addition, grip strength has been shown to be a key predictor of disability in older age (Bohannon, Peolsson, Massy-Westropp, et al., 2006). In particular, a recent meta-analysis (Cooper, Kuh, & Hardy, 2010) has shown that grip strength was associated with lower subsequent mortality rates. Considering the key role that grip strength plays as a clinical tool used to measure physical functionality in older adults, it is important to understand whether part of the decline in grip force can also be attributed to psychosocial factors; such as the impact of stereotype threat and age-stereotypes that operate implicitly.

Research examining the impact of age-stereotypes upon grip force have been limited in terms that research has focused primarily upon the effects of stereotype threat (explicit stimuli) upon grip force in older adults, and no research to date has experimentally manipulated the effects of implicit positive and negative age-stereotypes using a priming paradigm to examine the effects of subliminal age-stereotypes upon the

grip force of older adults. A recent study by Swift, Lamont and Abrams (2012) considered the effect of social comparisons on older adult's ability to perform tests that are often used in health or clinical settings to assess the needs of older adults and subsequently their capabilities, e.g., grip strength. Fifty-six older adults were randomly assigned to either the stereotype threat condition (in the form of a social comparison) or a control condition. Those placed in the comparison condition were informed that the aim of the research was "*to see whether older people perform differently on various tasks and the ways in which they deal with the world in comparison with young people. Both older and younger people will be taking part in this research,*" while those placed in the control condition were informed that the aim of the research was "*to see how they deal with the world and perform in various situations.*"

Results highlighted that for those older adults that were placed within the social stereotype threat condition, both grip strength and grip persistence were significantly reduced when told their performance would be compared to that of the younger adults. While the study reports a statistically significant effect of arthritis on grip strength, the effect of the social comparison condition still remains statistically significant in reducing older adults' performance on the grip strength test. In addition, results also demonstrate that for those older adults placed in the social comparison condition, grip strength was reduced by up to 50% in comparison to those placed in the control condition. These results combined with previous research highlights the severity of the effect that stereotype threat can have upon the grip strength of older adults. As stated previously, research has demonstrated that grip strength can decline by up to 50% after the age of 50+ years (Bohannon et al., 2006). Combined with the findings that grip strength can be reduced by a further 50% due to stereotype threat, this would suggest that in daily living, when older adults are placed in situations where they experience social comparisons to younger adults (e.g., when medical and social care staff ask older

adults to compare their physical functioning to when they were younger), their grip strength could be reduced to functioning at approximately 25% of their actual capabilities. This could be limiting older adults in performing essential everyday tasks so that they can continue living at home independently, but it could also have dangerous consequences. For instance, this may increase the likelihood of dropping a kettle whilst trying to pour a cup of hot tea, or spilling the hot water in the cup of tea.

These findings also raise serious concerns for older adults when we consider how many physical assessments an older adult is likely to undergo in the later years of their lifespan. For instance, it is likely that older adults will experience assessments by clinicians for social care and additional support assessments, medical requirements, insurance or even for employment purposes. Subsequently, it is important that clinicians are sensitive to using appropriate language when working with older adults, as one possibly damaging consequence of a physical assessment that explicitly uses language, such as "*in comparison to when you were younger*" as a reference point, may actually activate stereotype threat by asking older adults to compare themselves to younger people. In turn, this can influence older adults' performance on the task, ultimately causing them to present as less physically able than they really are. This may encourage a downwards spiral, promoting older adults to withdraw from physical tasks, which in turn would promote further decline in physical functionality (Horton, Baker, & Deakin, 2007).

2.9.2 Implicit age-stereotype priming and physical function outcomes

Similar to research into memory, it also appears that exposure to age-stereotypes may affect physical functionality in a subtle manner, as there is evidence to suggest that the kind of implicit age-stereotyping that occurs outside of conscious awareness can have an immediate, and dramatic impact on a variety of different tasks; ranging from simple handwriting tasks to more complex walking speed tasks.

Levy (2000) examined the effects of age implicit stereotypes on handwriting in older adults, a physical activity that could be considered as a simple task important to functioning in a daily living context. Additionally, handwriting is considered to be an automatic process which is not under our conscious effort (Allport & Vernon, 1933). Research indicates that even this automatic process, such as handwriting are affected by age-stereotypes. Levy (2000) initially collected handwriting samples from older adults, before they were randomly assigned to either a positive or negative age stereotype prime condition, where age stereotype words were flashed on a PC screen. In order to ensure that participants were not aware that they were being primed and that the stereotypes were in fact 'implicit' by nature, words were flashed at speeds which they argued to be fast enough to ensure that they were not consciously perceived by participants, but the speed was also slow enough to ensure that the message of the primes was encoded. After completing the prime condition, a second sample of handwriting was collected from the participants. An investigator who was blind to the priming condition selected neutral words from each of the participants' writing samples. After this, a panel rated the handwriting samples of those participants who were exposed to the negative age stereotype primes as significantly more "shaky," "deteriorated," and "senile" when compared to the writing samples of those who received the positive age stereotype primes. Generally, these findings suggest that even automatic physical functioning tasks are vulnerable to the influences of culturally relevant age stereotypes.

It appears that effects of age-stereotypes are not only limited to simple, automatic manual abilities, as a number of studies have reported effects from age-stereotypes on locomotor tasks, using walking (gait) speed as a simple dependent measure. Walking speed is thought to be important for older adults to age 'successfully' as it is thought to predict general functionality in older age (Alexander, 1996). Bargh,

Chen and Burrows (1996) originally investigated the effect of activation of the 'elderly' stereotype upon the walking speeds of older adults. The time taken for participants to walk 9.5m was measured surreptitiously by a confederate researcher, as each participant walked along the corridor towards the lab. After entering the lab, participants were randomly assigned to either a neutral or negative age-stereotype priming condition, where participants were asked to complete a 'sentence completion' tasks. Those participants in the neutral condition were asked to complete sentences that were not related to ageing, while those in the negative condition were asked to complete negative age-stereotypical sentences. After completing the tasks, participants then walked along the same corridor, for 9.5m to exit the lab. Again, a confederate researcher measured the time taken to complete the 9.5m walk. Results indicated participants who had completed the negative age-stereotype condition walked significantly slower compared to those who completed the neutral age-stereotype prime condition. These results indicate that age-stereotypes can unconsciously influence performance on action tasks that are thought to be more complicated and require additional resources in comparison to that of relatively simple writing tasks.

Adopting a different implicit priming method, Hausdorff et al (1999) have replicated similar results to that of Bargh and colleagues, finding that older adults' walking speeds can be improved by positive implicit age-stereotype words. Hausdorff and colleagues exposed older adults to subliminal positive age-stereotype word primes using the same subliminal priming paradigm that was described by Levy (1996), during which positive age-stereotypical words were flashed on a PC screen at speeds they argued were fast enough to ensure participants were not consciously aware of the words. To measure gait, participants were asked to walk at their self-determined, natural pace for a total distance of 45 meters, before and after exposure to the subliminal priming paradigm. The findings of this study concluded that exposure to the positive age-

stereotyped word primes significantly increased walking speed compared to baseline measures. What is of particular interest from these results is that the improvements in walking speed after exposure to the positive age-stereotype word primes were comparable to that of improvements which had been documented by other physically demanding physio-therapy programmes.

Walking speed is important in the day-to-day functioning of older adults, particularly if they are to maintain an active lifestyle and live independently at home for as long as possible. Additionally, gait is also thought by many researchers to be an indicator of frailty, and integrated physical functioning (Chandler & Hadley, 1996; Judge, Ounpuu, & Davis, 1996). Previous research is limited theoretically, however, as walking speed as a standalone measure has limitations in predicting abilities across a range of everyday tasks. For instance, we cannot necessarily rely on walking speed as the only measure of health and functioning, as in the current cultural which is endeavouring to increase diversity awareness, there is an increase in older adults who use wheelchairs to compensate for disabilities which are not necessarily related to ageing. For these individuals, a 'simple' walking task is not appropriate to be used to assess functional health. Therefore, other it is important that age-stereotype research also considers other markers of health and functioning. There are other markers of functional health which would be easier to measure, such as grip strength, which is also a key marker of successful ageing, which predicts nursing home admissions (Alexander, 1996), and health related outcomes such as disability (Rantanen, Volpato, Ferrucci, Heikkinen, Fried, & Guralnik, 2003) and mortality (Volaklis, Halle, & Meissinger, 2015). In addition, the hand experiences some of the most age-related changes within the human body, and tasks which require people to perform a simple precision grip (using predominantly the thumb and index finger) show the most severe age-related changes (Carmeli, Patish, & Coleman, 2003). The ability to perform a simple precision

grip task is essential for many everyday tasks, which are required to remain independent and fully functional whilst living at home. For instance, a precision grasping ability is required to correctly eat from a spoon, drink from a glass, and write with a pen (Carmeli et al, 2003) as these types of grasp require precise control of the moments produced by the digits that act upon the handled object. If this control is impaired, the drink can be spilled, the food could make a mess, and in the case of Levy's (1990) early work, handwriting could become illegible. Yet, at present, little to no research has considered how age-stereotypes can influence this particular grip strength task.

Recent research has highlighted that some measures of maximum grip strength are sensitive to manipulations in age-related stereotype primes. Whilst there are numerous ways in which an individual can lift an object, and many everyday tasks require different grasping motions, research has only considered the influence of age-stereotypes on a power grip (a cylinder-shaped grasping action that resembles the way we grip a lever to manipulate it). Studies manipulating older adults' attitudes towards ageing, using an age-stereotype priming design, demonstrate that maximum grip force exerted during a power grip task can also be increased after exposure to positive age-stereotype primes. However, to date, not study has investigated whether precision grip strength can be significantly reduced by negative age-stereotype priming.

In summary, implicit negative age-stereotype priming research has shown that age-stereotypes can influence older adults' physical functioning. For instance, exposure to negative age-stereotypes has been shown to impair hand writing performance (Levy, 1996), and reduce walking speed (Bargh, Chen and Burrows, 1996; Hausdorff et al, 1999). Whilst walking speed is important for older adults to function in daily living, previous research is limited from a theoretical perspective in that there are other reliable markers of functional health in ageing (such as grip strength), that have so far been overlooked by age-stereotype research. The following section will continue to discuss

the key gaps in previous research from a theoretical and methodological perspectives in more detail.

2.10 Unanswered questions of age-stereotype research

The previous implicit age-stereotype priming literature has 3 commonly cited methodological limitations, implicit age-stereotype priming studies have all relied upon positive and negative age-stereotype prime words that were generated by Levy (1996), using a sample of North American older adults. This is problematic, as while age-stereotypes across many western cultures do share some similarities in terms of their content, there are small variations in these cultures and societies which creates varying attitudes and beliefs about the ageing process (Lockenhoff et al, 2006). For instance, many American adjectives (such as “diseased” and “learned”) were used as age-stereotype word primes and these are not necessarily used to describe old age in the UK. It is therefore important that implicit age-stereotype priming develops culturally relevant age-stereotype prime words before implicitly priming these in order to ensure that these are representative of culturally popular age-stereotypes within the UK.

A second key limitation is that studies often lack a neutral priming condition, yet the ability to compare the effects of positive and negative primes against neutral primes is required to determine that changes in performance are due specifically to the positive or negative valence of the age-stereotyped word primes, and not some other characteristics of these stimuli. A neutral word prime condition is also required to allow researchers to establish the exact amount of change in performance (if any) that is due to the priming effects.

The third, and final limitation is that studies employing implicit age-stereotyped word primes have adopted similar priming paradigms whereby the implicit word prime were flashed on a screen for one of three possible presentation speeds (e.g., 116, 66, & 56 ms). Three categories, however, are unlikely to sufficiently account for the high

degree of variation in age-related decline in visual processing speed that is commonly found within older adults (Wiegand, Töllner, Dyrholm, Müller, Bundesen, & Finke, 2014). This may have underestimated the effects of age-stereotyped word primes on older adult's abilities. In addition, it is possible that this may also explain why some researchers have failed to replicate age-stereotyped word priming effects (Horton, Baker, Pearce, & Deakin, 2010).

One recent study (Levy, Pilver, Chung, & Slade, 2014), albeit limited in using positive (but not negative) age-stereotyped word primes only, has begun to address these concerns. Levy et al. updated the subliminal priming paradigm to accommodate greater variation in visual processing speed by including a much wider range of prime presentation speeds. During the priming paradigm, participants would see a flash appear above or below a bulls-eye, and each flash was actually a stereotype word and visual mask. Participants were interviewed at 7 time points over the course of the 8-week study, and during each interview they would re-complete the same priming paradigm. Physical function and self-perceptions of age were assessed at the 7 time points by: (a) time to walk eight feet; (b) time to rise from a chair and return to seated position; and (c) the ability to stand side by side in semi tandem and tandem position for 10 seconds.

Results of the study have highlighted that the physical functioning of older adults can be improved over time through repeated exposure to implicit positive age-stereotypes. Those older adults who were placed in the positive ageing prime condition demonstrated a significant improvement in walking speed, time taken to rise from a seated position, and the ability to stand with feet together in the side-by-side position for 10 seconds. Similar to previous research that has investigated the impact of positive age-stereotypes on gait in older adults over a single session (Hausdorff et al., 1999), the improvement in these numerous measures was greater than that of improvements recorded by a six-month intensive exercise intervention that also used a similar age

group of participants (McAuley et al, 2013). The improvements also lasted approximately three weeks after completing the last intervention session.

A particularly interesting finding from Levy et al (2014) is that the positive age-stereotype primes actually improved performance by first increasing positive self-perceptions of age (an individual's expectations and beliefs about their own ageing experience), which then in turn was followed by improved physical performance on the tasks. These findings are interesting because they highlight that older adults' self-perceptions of ageing are a potential individual difference that mediates the effects of the age-stereotypes on physical performance. To date, however, no study has examined whether older adults' self-perceptions of age leave some more susceptible or vulnerable to the effects of age-stereotypes than others.

At present, few published studies have considered whether individual differences in older adults can render some older adults more vulnerable to age-stereotypes. The only two individual differences which have previously been considered are 'domain investment' and education levels. The notion of investment in the domain being evaluated is an important component of stereotype threat theory. Studies amongst different populations have found that those more invested in a particular domain are generally more susceptible to a negative stereotype. For instance, within younger adults, stereotype threat impacted more upon performance across several different domains when the stereotypes involved a valued trait or an important part of the individual's identity (e.g., Steele & Aronson 1995; Spencer et al., 1999; Leyens. Désert, Croizet, & Darcis, 2000). The findings within seniors have been more equivocal, though. Hess et al. (2003) originally suggested that older adults' investment in the domain of memory mediated the effects of age-stereotype threat upon memory performance. Whilst this was so, no subsequent research (Hess et al., 2004, Hess & Hinson, 2006) has since replicated these findings. Instead several studies have found no effect of domain

investment mediating the effects of age-stereotypes upon memory performance (Horton et al, 2010).

Andreoletti and Lachman (2004) investigated whether education levels would leave young, middle-aged and older adults' vulnerable to the effects of age-stereotypes on a memory performance task. Results demonstrated that whilst the age-stereotypes affected only the memory performance of older adults, the age-stereotype threat condition effects did vary as a function of education. For those participants with less education, the effects of the age-stereotype threat (information regarding age differences on the memory task) resulted in lower recall performance compared to those with higher education levels. More specifically, results concluded that older adults who had completed less than 4 years of further education (the standard time taken to complete a bachelor's degree) were more at risk to experience the effects of age stereotype threat upon memory performance, compared to those older adults who had completed more than 4 years of further education. Recent research (Smith et al, 2017) has replicated similar findings, demonstrating that older adults with lower levels of education were more likely to recall false information during a memory task after exposure to negative age-stereotypes in comparison to those older adults with higher levels of education.

The age-stereotype literature and self-perception of age literature have developed rather independently of one another. As mentioned above (Levy et al, 2014) a second relevant individual difference that may leave some older adults more vulnerable to the effects of negative age-stereotypes is self-perceptions of age. Whilst no research has divided older adults based on self-perceptions of age and experimentally examined the effects of age-stereotypes, it is clear that those older adults with more positive self-perceptions of age do experience increased measures of functional health in later life. For instance, those older adults with more positive self-perceptions of age experienced fewer health problems that interfered with their ability to perform everyday

tasks (Levy, Slade, Kunkel, & Kasl, 2002), experience less hearing loss (Levy, Slade, & Gill, 2006) and live on average 7.6 years longer than those with negative self-perceptions of age (Levy et al, 2002). Ultimately, taken together with Levy et al's (2014) finding that improvements in functional health measures following positive priming was accompanied by improvements in self-perceptions of ageing, this demonstrates that older adults' self-perceptions of age may act as an individual difference, leaving some older adults with poorer self-perceptions of age more vulnerable to age-stereotype effects.

To sum up, previous age-stereotype priming research within physical functioning is limited from theoretical and methodological aspects. From a methodological aspect: (1) Previous research has often failed to include neutral priming conditions, leaving researchers unable to compare the effects of positive and negative priming conditions so as to examine the extent of the age-stereotype effects on performance; and (2) Priming research is often criticised as not accounting for the wide variation range in older adults' visual processing capabilities. From a theoretical perspective: (3) previous research has left unanswered questions as to whether age-stereotypes primes also influence other markers of health in ageing, such as grip strength during a precision grasping task; and (4) whilst there has been little research considering whether individual differences make some older adults more vulnerable to the adverse effects of age-stereotypes, what research does exist, highlights that older adults' education levels and self-perceptions of age can leave some older adults more vulnerable to age-stereotypes.

2.11 Literature review summary

The introduction to age-stereotypes within this thesis has shown that age-stereotypes are formed at a young age in childhood, operating within children from as young as 6 years old; stereotyping older adults as lonely, sad and frail (Seefeldt et al,

1977). It is thought that throughout the remaining life span, frequent exposure to such age-stereotypes can cause negative ageing stereotypes to become ingrained in an individual's perception of the ageing process, creating the perception that the ageing process is wholly a negative experience, associated only with decline (Levy et al., 2002). With older adults being amongst the only group that do not demonstrate a 'in group' preference, the attitudes expressed towards the ageing process by younger and older adults highlight that there is a strong degree of similarity between the two groups attitudes. Ultimately, this alludes to the stance that older adults' express attitudes towards other older people that are equally as negative as those expressed by younger adults, and often these attitudes operate below individual's level of conscious awareness (Nosek et al, 2002). These perceptions towards the ageing process can ultimately manifest themselves in terms of self-stereotypes, which according to stereotype embodiment theory (Levy, 2014) ingrained age-related stereotypes in older age can be used to guide 'appropriate' actions and behaviours, and as such influence older adults cognitive functioning, physical abilities, and decision-making processes.

The effects of age-stereotypes are unfortunately not limited only to one domain of functioning. A plethora of studies have focussed on the cognitive effects of age-stereotypes, highlighting that negative age-stereotypes can reduce memory performance on immediate, learned and delayed recall, photo recall, auditory recall and metamemory (Levy, 1996). Less focus has been paid on the physical effects of age-stereotypes, however, research to date does show that negative age-stereotypes can also impair hand writing performance (Levy, 1996) and reduce walking speed (Bargh, Chen & Burrows, 1996; Hausdorff et al, 1999). As the physical functioning domain has received less research attention, it is limited from theoretical and methodological aspects.

From a methodological aspect: (1) Previous research has often failed to include neutral priming conditions, leaving researchers unable to compare the effects of positive

and negative priming conditions so as to examine the extent of the age-stereotype effects on performance; and (2) Priming research is often criticised as not accounting for the wide variation range in older adults' visual processing capabilities. From a theoretical perspective: (3) whilst walking speed is important for older adults to function in daily living, previous research is limited from a theoretical perspective in that there are other reliable markers of functional health in ageing (such as grip strength), which have so far been overlooked by age-stereotype research. This is problematic as grip strength is required to perform an array of daily living tasks (Simard et al., 2012) and is also considered to be a key marker of successful ageing, which predicts nursing home admission, and health related outcomes such as disability (Rantanen, Volpato, Ferrucci, Heikkinen, Fried, & Guralnik, 2003) and mortality (Volaklis, Halle, & Meisinger. 2015). (4) Finally, little research has considered whether individual differences make some older adults more vulnerable to the adverse effects of age-stereotypes. What little research has examined the role of individual differences has centred around domain investment and education levels; leaving unanswered questions as to whether other relevant individual differences, such as self-perceptions of age, leave some older adults (such as those with poorer self-perceptions of age) more vulnerable to the effects of age-stereotypes.

2.12 Outline of the present thesis

Research has highlighted that older adults' self-perceptions of age can be predictive in nature for physical ability and general health. Studies have demonstrated that older people who tend to endorse negative self-perceptions of age also demonstrate a trend to self-report having worse physical health with age (over a 18-year period), reporting more health conditions that interfere with their ability to perform daily living tasks. This make intuitive sense as frequent exposure to such age-stereotypes can cause these to become ingrained in an individual's perception of the ageing process, creating

the perception that the ageing process is wholly a negative experience, associated only with decline (Levy et al., 2002).

To date, it is still unclear as to whether self-perceptions of age are associated with other key bio-markers of successful ageing, such as grip strength. As such, the first objective of the current PhD thesis is to consider whether older adult's self-perceptions of age are naturally associated with grip strength (independently of age) during a grasping task. The relationship between age-stereotypes and grip strength is a key area of interest because handgrip strength is considered to be a key bio-marker that is widely accepted as a measure of how successful an individual is ageing and it is also considered as a measure of overall physical functioning, which consistently predicts health related outcomes, such as mortality, disability, and other health-related complications amongst older aged adults (Ling et al., 2010; Rantanen et al., 2000).

The second objective of this thesis is to develop a bespoke age-stereotype priming task which addresses the following methodological limitations of previous research. (1) Previous research is limited in that it often relies on already existing age-stereotype prime words, which were created by Levy et al (2000) using a North American sample of participants. This is problematic as while age-stereotypes across many western cultures do share some similarities in terms of their content, there are small variations in these cultures and societies which creates varying attitudes and beliefs about the ageing process (Lockenhoff et al, 2006). (2) Secondly, a recent meta-analysis (Meisner, 2012) highlights that studies often lack a neutral priming condition, yet the ability to compare the effects of positive and negative primes against neutral primes is required to determine that changes in performance are due specifically to the positive or negative valence of the age-stereotyped word primes, and not some other characteristics of these stimuli. Plus, it also provides a baseline to be able to quantify the impact of the age-stereotype primes. (3) Previous research employing implicit age-

stereotyped word primes have adopted similar priming paradigms whereby the 'subliminal' word primes were flashed on a screen for one of only three possible durations (116, 66, & 56 ms). Three categories, however, are unlikely to sufficiently account for the high degree of variation in age-related decline in visual processing speed (Wiegand, Töllner, Dyrholm, Müller, Bundesen, & Finke, 2014), which may have underestimated the effects of age-stereotyped word primes on older adult's abilities.

The third objective of this thesis is to advance previous research from a theoretical perspective by examining whether the effects of age-stereotypes extend to other key markers of functional health in later life: grip strength and self-perceptions of age. As mentioned above, grip strength is considered to be a key bio-marker that is widely accepted as a measure of how successful an individual is ageing, and it is also considered as a measure of overall physical functioning. To achieve this aim, I will use the improved age-stereotype priming paradigm outlined above to experimentally test the effects of negative, positive and neutral age-stereotyped word primes on younger and older adults' grip strength levels during a simple reaching and grasping task. I will also examine the effects of age-stereotyped word primes on older adult's self-perceptions of age and examine whether self-perceptions of age mediate the effects of the age-stereotyped word primes on older adults' grip strength levels.

Furthermore, knowledge about which individual differences contribute to stereotype sensitivity may be useful for identifying those most at risk of age-stereotype effects in real world scenarios. My fourth objective is to expand previous research theoretically by examining whether specific individual differences (such as self-perceptions of age) leave some older adults with an increased vulnerability to age-stereotype effects. More specifically, to achieve this objective I will split participants based on self-perceptions of age scores, and investigate whether self-perceptions of age influence the effects of negative, positive and neutral age-stereotyped word primes on

older adult's grip strength, i.e., determine whether those older adults who report poorer self-perceptions of age are more or less vulnerable to the effects of age-stereotype word primes and examine whether the age-stereotyped word primes operated in a cumulative manner to affect grip strength.

My final objective is to use the knowledge that is gained from these studies to make recommendations for intervention, i.e., should interventions have a psycho-social focus?

Chapter 3: Study 1: The Relationship between Self-Perceptions of Age and Grip Strength in Younger and Older Adults.

3.1 Introduction

A large proportion of people believe that physical and cognitive functioning will only decline as their age increases (Sarkisian, Hays, & Mangione, 2002). Researchers on the other hand disagree with the simplicity of this assumption, who often consider ageing as occurring in a mosaic pattern, encompassing both decline and growth of abilities in older age (Light, 1994). Despite this, many of the stereotypes that surround the ageing process purely focus upon inevitable, irreversible and severe decline, whilst simultaneously ignoring the benefits that can come with growing older (Minichiello, Browne & Kendig, 2000).

In younger years, being told to 'act one's age' is associated with connotations of behaving in a responsible manner with expectations of industry and appreciating the gravity of the situation at hand. For older adults, ironically, 'acting one's age' can lead to expectations of doing the opposite of this; when older adults are instructed to act their age (Löckenhoff et al, 2009) in Western cultures this is often accompanied by expectations to act more like children, by relinquishing control over their own lives and responsibilities, to younger family members. While there is no doubt that society and culture allow for expectations regarding appropriate behaviours of older adults (Ryan, Hummert, & Boich, 1995; Löckenhoff et al, 2009), how do these expectations influence functionality in older age?

A major focus of previous research into physical functioning in old age involves behavioural and biological predictors of physical functioning. More recently, the importance of psychological wellbeing and self-perceptions of age have been recognised as having independent influence on physical health outcomes (e.g., Levy,

Slade, & Kasl, 2002). Self-perceptions of ageing refer to individuals' perceptions of their own age and ageing (Levy, 2003; Sneed & Whitbourne, 2005).

Levy argues that self-perceptions of old age are acquired and reinforced during the lifespan (Levy, 2009), which in old age develop into self-fulfilling prophecies. These expectations and beliefs throughout the lifespan create a framework within which older individuals interpret their ageing experience, particularly when salient processes of ageing are experienced, such as problems with health and physical functioning. It is this framework that evolves into self-perceptions of ageing (SPA), the lens through which ageing experiences are interpreted. An individual's self-perception of ageing can range from positive to negative depending on the domain in question, and the extent to which the internalization of positive and negative age-stereotypes has occurred (Levy, Slade, Kunkel, & Kasl, 2002: Sarkisian, Hays, & Mangione, 2002).

The negative impact of poor subjective age, and poor attitudes towards ageing on older adults' subjective health has been well documented (Jang, Poon, & Martin, 2004; Kim, 2009; Moor, Schmitt, & Kliegel, 2006). For instance, old-old adults aged 80 years and over, who experienced a higher number of diseases, not only subjectively rated their health as poorer, but also attributed these diseases as an inevitable part of the ageing process, rather than being linked to poor lifestyle and health behaviours (Jang, et al., 2004). It seems that older adults who endorse more negative expectations of ageing not only feel subjectively that they have poorer health, but in fact, actually take worse care of their health. For instance, older adults who report more negative expectations of ageing consider seeking medical help for reversible age-related declines, such as depression and urinary incontinence, as being less important compared to those who report positive expectations of the ageing process (Sarkisian et al., 2002). Self-perceptions of age have also been shown to both directly predict health behaviours, with older adults who endorse positive self-stereotypes engaging in significantly more

preventative health behaviours, and subsequently taking better care of their health (Levy, 2004). For instance, over a twenty-year period, older adults who hold negative self-stereotypes of aging were less likely to engage in more preventative health behaviours such as attending regular GP visits, wearing a seatbelt whilst driving, participating in regular exercise, maintaining a healthy diet, complying with medication schedules and consuming more tobacco based products (Levy et al., 2004).

Further research has suggested that self-perceptions of age are also linked to self-report measures of health. For instance, within a sample of older adults, those who reported more negative self-perceptions of age also demonstrated worse hearing 36 months after an initial assessment and experienced a steeper rate of decline compared to those older adults with positive self-perceptions of age. Structural equation modelling suggested that, for those older adults holding more negative self-perceptions of age, the decline in hearing over the 36-month period was equal to that of hearing loss experienced naturally over an 8-year time period of someone who reports positive self-perceptions of age.

Levy, Slade and Kasl (2002) also showed that older adults' self-perceptions of age significantly predicted older adults' scores on the HSA (Health Scale for the Aged) over an 18-year period, which assesses an individual's ability to perform physically demanding house chores, such as the ability to walk up and down stairs, and work in full-time employment.

It is clear that older adults' self-perceptions of age predict self-report measures of physical health. However, one main criticism of previous research is that very few studies have investigated the relationship between older adults' self-perceptions of age and a performance-based measure of physical health.

Of the limited research that has been conducted, results indicate that older adults' self-perceptions of age do also predict performance-based measures of health

and well-being. For instance, Levy et al., (2000) demonstrated that those older adults who endorse negative self-perceptions of age are also more likely to experience increases in both systolic and diastolic blood pressure, as well as increased heart rate, leading to a higher likelihood of experiencing a cardiovascular event (Levy et al., 2000). In fact, in a sample of adults aged 49 years and under, those who held more negative self-perceptions of age were 12% more likely to experience a cardiovascular event after the age of 60 years old. More recent research has also highlighted that self-perceptions of age can predict Alzheimer disease biomarkers. Levy, Slade, Zonderman, and Troncoso (2015) measured self-perceptions of age at baseline, before following up with measurements of hippocampal volume and neurofibrillary tangles and plaques over a 20-year period. Results demonstrate that those older adults who express more negative self-perceptions of age experienced a significantly steeper decline in hippocampal volume, a significantly greater accumulation of amyloid plaques, and significantly more neurofibrillary tangles over the 20-year period, compared to those who held more positive expectations regarding the ageing process. The authors argue that baseline measurements of self-perceptions of age were taken more than 20 years prior to the measurement of hippocampal volume, as well as plaques and tangles. In addition, all participants were 'dementia free' at baseline measurements, confirmed by initial MRI scans. Therefore, these findings could not be a product of dementia biomarkers predicting negative self-perceptions of age.

Unsurprisingly, it also appears that self-perceptions of age are related to an individual's longevity (Levy, Slade, Kunkel and Kasl, 2002). Using a sample of 660 older adults recruited via the OLSAR (Ohio Longitudinal Study of Ageing and Retirement), self-perceptions of ageing significantly predicted longevity over a 26-year period, with those older adults who hold more positive self-perceptions towards ageing living 7.6 years longer than those who held negative views towards ageing. More

specifically, the beneficial effects of positive self-perceptions on longevity seem to be greater than that of cholesterol and systolic blood pressure, both of which are associated with an increase in longevity of approximately 4 years, demonstrating the extent of the role that self-perceptions of age can play in predicting successful ageing. Finally, in most of these studies, self-perceptions of age rivalled or outperformed chronological age as a predictor of psychological and health-related outcomes in old age (Kotter-Grühn et al, 2009; Stephan et al., 2011; Westerhof & Barrett, 2005).

While previous research has highlighted the relationship between self-perceptions of age and physical functioning outcomes, it is limited in that it has primarily focussed on self-report measures of physical functioning with only two studies using a performance-based measure of physical function (blood pressure and hippocampal volume). While it is thought that self-report measures can correspond with performance-based measures of physical function (Latham, Mehta, Nguyen, Jette, Olsarch, Papanicolaou & Chandler, 2007), at present, research has not considered the relationship between self-perceptions of age and key performance-based measures of health in ageing such as grip strength. Handgrip strength is a surrogate measurement of overall physical functioning, which consistently predicts health-related outcomes such as premature mortality, disability, and other health-related complications among middle-aged and older adults (Ling et al., 2010; Rantanen et al., 2000). Yet, to date, no study has investigated the relationship between self-perceptions of age and grip strength.

As outlined in chapter 1, the primary aims of this thesis (and experimental chapters) are to examine the effects of age-stereotyped word primes upon older adults' grip strength and examine the role that older adults' self-perceptions of their own age plays in these effects. The introduction of the study also highlights that previous

research had primarily focussed upon self-report measures of functional health leaving unanswered questions surrounding key performance-based measures of health.

With this in mind, the current study had one key aim. Before conducting any experimental studies, it was important that the current study established whether or not there was a natural association between self-perceptions of ageing and grip strength performance (a key marker of health and ageing) within older adults.

As such, in the current study, both younger and older adults reported their self-perceptions of age and were given a simple grasping task to perform. The goal of study 1 was to examine the relationship between self-perceptions of age and peak grip strength levels during a simple grasping task to determine whether a natural association was present amongst older adults' self-perceptions of age and grip strength, and whether this was independent of increasing age. In line with previous research (Levy et al., 2000; Levy et al., 2011; Stephan et al., 2012) I predicted that:

H1: Self-perceptions of age would be positively related to grip strength levels within the older adult group. Those older adults with, better self-perceptions of age would predict better grip strength (and vice versa) during the grasping task, independent of increasing age.

3.2 Method

3.2.1 Participants

A power analysis using G*Power (Faul, Erdfelder, Buchner, & Lang, 2009) informed that a sample size of 48 participants in each age group would be required in order to detect significant one-tailed correlation between the two variables (Self-perceptions of age and grip strength), whilst also achieving sufficient power (at the 0.90 level [Cohen, 1998]).

With this in mind, forty-eight older adults (60-91 years, M = 71.86, SD = 5.78,

75% female) and 48 younger adults (18-29 years, M = 25.36, SD = 6.00, 79% female) participated in study 1. Younger adults were recruited using Heriot-Watt University's research participation scheme in exchange for course credits. Older adults were recruited from an older person's information day in Edinburgh, where a stall handed out fliers offering the opportunity to participate. Written informed consent was given by all participants prior to participation, and all experimental procedures were approved by the Ethics Committee at Heriot-Watt University.

3.2.2 Materials and Equipment

Screening. In addition to the Mini Mental State Exam (MMSE, Folstein & McHugh, 1975), participants completed a health questionnaire. Participants were excluded from the study if they: (1) scored less than 27/30 on the MMSE, (2) reported a neurodegenerative, eyesight or movement disorder (e.g., arthritis), or (3) were taking medications that may cause tremors during a grasping action.

Independent variable: Self-perceptions of age. Consistent with previous research (Liang & Bollen 1983; Levy et al., 2004), participants' self-perceptions of their own ageing experience were measured using the five-item subscale of the Philadelphia Geriatric Centre Morale Scale (Lawton, 1975). Items were rated on a 5-point scale (ranging from 1- strongly disagree to 5- strongly agree (higher scores indicate greater satisfaction with their own ageing experience). The subscale consists of items such as: "As I get older, things are (better, worse or the same) as I thought they would be."

Outcome variable: Grip strength. Grip force was measured in newtons (500 Hz) using a single 6-axis force sensor (Nano 17 transducer, ATI industrial automation, NC). Each object that participants lifted had a plastic mount on the centre of its top surface, containing the force sensor. Participants used this handle to grip and lift the object with their thumb and index finger on a pair of textured finger pads with a diameter of 25mm. During practice trials, participants were asked to grasp a small cube,

and during test trials a small cylinder was used. Both objects were made from black plastic, and tailored to a height of 7.5 cm, and weight of 200g. Grip force is generally known as 'grip strength' across the various domains of health and well-being that the current thesis is relevant/applicable to, thus is herein referred to as grip strength.

3.2.3 Procedure

The study took place in The Motor Control Laboratory at Heriot-Watt University. On arrival, participants completed two short screening measures: the MMSE and a short health questionnaire. Participants who met the screening criteria completed the self-perceptions of age measure. Participants then completed two practice grasping trials using a precision grip with their thumb and index finger. Participants were asked to lift the small cube "*straight upwards, with your thumb and index finger on the handle, in a smooth and confident fashion, around 5cm off the table, and aim to hold it steady without exerting unnecessary effort.*" An initial auditory sound indicated to participants to begin the grasping task by lifting the cube from the lift-off pad, and after having held the cube for 6 seconds, a second auditory sound signalled to participants to lower the object back down. After completing the practice trials, participants were asked to perform the grasping task five times in line with the above procedure, this time using the cylinder test object.

In order to ensure that measuring self-perceptions of age prior to testing grip strength was not itself acting as an ageing prime and influencing grip strength performance, complete counterbalancing was used so that an equal number of participants were asked to rate their self-perceptions of ageing either prior to or post performing the grip strength task. This counterbalancing method was incorporated for every study of the current thesis.

3.3 Results

3.3.1 Data Pre-Processing

Full Matlab code for the data pre-processing can be found at https://sites.google.com/site/obintlab/wiki/data-processing. Statistical analyses were performed in SPSS version 22.

It is well established that the force rates on initial trials only can serve as an index of sensorimotor prediction, before motor learning processes adapt the fingertip forces from the expected to actual mass of the objects (Buckingham, Goodale, White, & Westwood, 2016; Flanagan & Beltzner, 2000). Therefore, within all analyses, the peak of GFR values on the first lift of test objects was examined.

3.3.2 Statistical Analysis

Contrary to expectations, older adults' grip strength levels were 1.48 newtons higher than that of the younger adults, and this difference was significant ($t(96) = -2.483$, $p = 0.001$). In contrast however, self-perceptions of age did not significantly differ between age groups ($t(96) = 1.71$, $p = 0.327$). (See Table 1). Whilst comparing older and younger adults grip strength levels and self-perceptions of age is not the key aim of the current study, this finding is none the less surprising, and not necessarily reflective of the pattern of results I might expect to find. They are, however, explainable. The grip strength scores for older adults in the current sample are high, and are also accompanied with a low standard deviation, meaning that the older adults consistently exerted higher grip strength during the grasping task. It is therefore possible that this is a result of recruiting a very healthy sample of older adults. This seems likely as I recruited all the older adult participants in the current study exclusively from physical activity classes; who are likely higher exert higher than average grip strength levels in comparison to less physically active older adults. As a result of sampling a group of very healthy older adults, it is possible that the current study actually

underestimates the strength of the relationship between self-perceptions of age and grip strength that would be found within a more representative sample of older adults who have a wider range in grip strength scores. This pattern of results will be discussed further in the discussion section of the current study.

Table 1

Table 1.1. Results of t-test and Descriptive Statistics for Peak Grip Strength and Self-Perceptions of Age, in Older and Young Adults (N=96)

	Age Group						95% CI for Mean Difference		
	Younger Adults			Older Adults					
	M	SD	N	M	SD	n		t	df
Peak Grip Strength (N/s) [a]	9.940	2.753	48	11.426	4.877	48	1.053, 1.919	-2.483**	95
Self-Perceptions of Age [b]	15.104	2.290	48	18.875	2.048	48	1.631, 2.617	1.71	95

**p < .001.

[a] Measured in newtons. Higher scores represent greater grip strength.

[b] Scored out of a total of 25. Higher scores represent more positive self-perception of own ageing experience.

Associations between self-perceptions of age and grip strength

To test the hypothesis that self-perceptions of age would be related to grip strength levels within the only the older adult sample (not the younger adults) a hierarchical multiple regression analysis was performed using the SPSS extension PROCESS (Hayes, 2018).

In the first step, two variables were included: self-perceptions of age and participants age. Results show that the overall model was significant; indicating that these variables account for a significant amount of variance in grip strength levels ($F(3, 92) = 37.16$, $p<.000$, $R^2 = .55$). Self-perceptions of age ($b = 1.60$, $t(92) = 4.37$, $p =$

0.00) significantly predicted grip strength levels, however age alone did not (b = 11.71, $t(92)$ = 1.473, p = 0.471).

Next, to avoid potentially problematic high multicollinearity with the interaction term, the variables were centred and an interaction term between self-perceptions of age and participant age was created (Aiken & West, 1991). As expected, the interaction between self-perceptions of age and participants age was significant (b = 1.51, $t(92)$ = 6.84, p = 0.00), indicating that the relationship between self-perceptions of age and grip strength varies across participant age groups.

In support of hypothesis 1, for young adults, there is no relationship between self-perceptions of age and grip strength (b = -0.10, t(92) = -0.57, p = 0.570). However, for the older adults, there is a significant relationship between self-perceptions of age and grip strength levels (b = 1.41, t(92) = 9.99, p = 0.00). Within the sample of older adults, for every 1-point increase in self-perceptions of age score, grip strength also increases by 1.41 newtons. This pattern of results is illustrated in Figure 1.1.

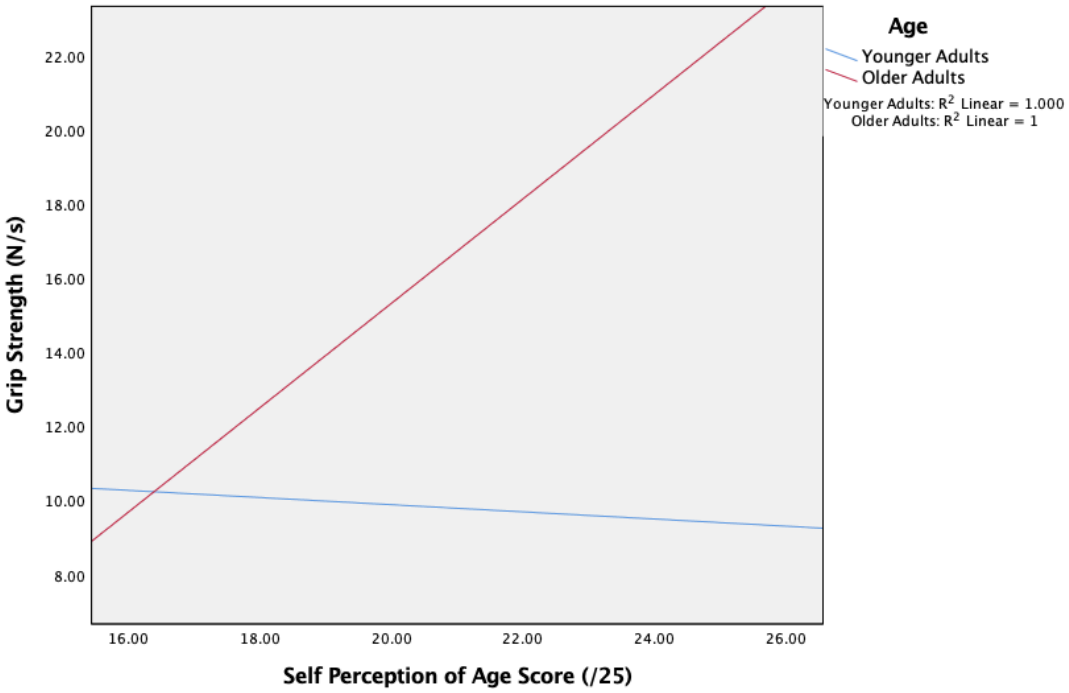


Figure 1.1

Relationship between self-perceptions of age score and grip strength levels for younger and older adults. (N = 48).

3.4 Discussion

Throughout recent years a plethora of studies have linked older adults' self-perceptions of ageing to self-report outcome measures of functional health and physical functioning (Jang et al, 2004; Kim, 2009; Moor et al, 2006; Levy et al, 2002). Previous research was limited in that all but two studies had focussed on the relationship between self-perceptions of age and self-report measures of functional health. As the key aim of the current thesis is to examine the impact of age-stereotypes on older adults' grip strength and self-perceptions of age of older adults, then prior to conducting any experimental studies in future chapters of this thesis, it was important that the current study established whether or not a natural association exists between self-perceptions of ageing and grip strength performance (a key marker of health and ageing) within older adults. With this in mind, the aim of study 1 was to establish whether there was a naturally occurring relationship between self-perceptions of age and grip strength within

older adults.

Contrary to expectations, the current study found that using a UK based sample of participants, older adults demonstrated significantly higher grip strength rates in comparison to the younger adults. Most crucially though, despite this slightly surprising pattern, the results still found that older adults' self-perceptions of age scores were positively related to peak grip strength during a simple grasping task, an association not found within the younger adults. This association between the self-perceptions of age and peak grip strength within the older adults occurred independently of increasing age. As the current findings highlight that a natural association does in fact exist between self-perceptions and grip strength, independently of increasing age, it has created a theoretical foundation for future studies within the current thesis to examine the exact role that self-perceptions of age play when examining the effects of age-stereotypes upon older adults' functional health (as measured by grip strength).

3.4.1 Evidence that self-perceptions of age are associated with older adults' functional health

The current section of the discussion will consider how the current findings compare to previous research investigating the relationship between self-perceptions of age and functional health in older age. It will then move on to discuss the implications of these findings.

An unexpected finding of the current work was that the older adults in our study demonstrated greater peak grip strength than younger adults during the grasping task. This may be surprising, as grip strength is known to decline in older age, even within healthy older adults (Sternäng, Reynolds, Finkel, Ernsth-Bravell, Pedersen, & Aslan, 2015). One possible explanation for this could be that the current older adult sample was fit, healthy, and self-selected. The current participants were recruited from physical activity classes that were aimed at promoting physical fitness and health for older adults

in the Edinburgh area. For instance, the current participants were recruited from a walking group, a carpet bowls class, and a seated exercise class. Considering that the current participants were recruited from only fitness classes, it could be that the older adults' increased grip strength may reflect their increased health and physical functioning status. The fact that the current study highlights that the results still support the predicted relationship between older adult's self-perceptions and functional health despite the older participants being fit and healthy, and is consistent with previous research, arguably indicates that the relationship between self-perceptions of age and grip strength is robust, as it exists within even the healthiest of older adults.

Reported self-perceptions of age scores in the current study also showed a trend to be slightly higher (i.e., more positive) for the older adults than the younger adults with a low standard deviation. This indicates that the current sample of older adults may have a consistently reported higher than average self-perceptions of age. This is also consistent with previous research considering attitudes towards ageing across the lifespan demonstrating that, whilst attitudes towards ageing can become increasingly negative during our younger and middle-aged years of development, for some individuals in older age (e.g., over 65 years old), self-perceptions of age can become more positive. This change in self-perceptions of age later in life is thought to be a proactive/adaptive defence strategy in order to protect against negative effects in the face of age-related declines (Hummert et al., 1994).

Overall my key predictions were supported, in that there was no relationship between self-perceptions of age and grip strength in the younger sample, whereas older adults' self-perceptions of age were positively associated with grip strength, independently of increasing age within the older group (age and self-perceptions of age did not correlate in either age group).

The current findings that older adults' self-perceptions of age are positively associated with grip strength during a simple grasping task expands previous research in two key ways. 1) This finding demonstrates the relationships previously found in older age between self-perceptions of age and self-report measures of health, as well as some performance-based measures of health in old age (e.g., blood pressure), also extend to motor control tasks that involve grip strength; a key marker of health and wellbeing in older age (Ling et al., 2010; Rantanen et al., 2000). 2) This is the first time that a relationship between self-perceptions of age and performance-based measure of health has been documented in a UK based sample of participants.

Previous research has well documented the impact of older adults' self-perceptions of age on several self-report measures of functional health in North American samples of older adults. For instance, older adults with more negative self-perceptions of subjectively rated their health as poorer (Jang et al., 2004), take poorer care of their health, and consider seeking medical help for reversible age-related changes as less important compared to older adults with more positive self-perceptions of age (Sarkisian et al., 2002). Over a twenty-year period, self-perceptions have also been shown to predict older adults' health behaviours, with those that report positive self-perceptions of age engaging in significantly more preventative health behaviours compared to those with negative self-perceptions of age. These health behaviours include activities such as, attending regular GP visits, participating in regular exercise, maintaining a healthy diet, and complying with medical regimes. It therefore comes as no surprise that older adults' who also report negative self-perceptions of age are more likely to experience increases in systolic and diastolic blood pressure, as well as being 12% more likely to experience increased likelihood of experiencing a heart attack (Levy et al., 2000).

The current finding that older adults' self-perceptions of age scores are positively associated with grip strength, has very clear implications for older adults' ability to remain living independently at home. For instance, the current grasping task asked participants to lift the object using their thumb and index finger. This particular grasping motion is known as a precision grasp. Motor control literature has shown this particular grasping action to experience the most severe age-related changes in comparison to other hand grasping motions (Carmel, Patish, & Coleman, 2003). The ability to perform a precision grasping action successfully is essential to be able to perform many everyday tasks, such as writing with a pen, correctly holding cutlery to eat, and the ability to hold a glass to drink from (Carmel, et al., 2003). Therefore, those older adults who express more positive self-perceptions of age are more likely to be able to successfully perform these daily living tasks for longer.

As previously discussed, grip strength is a key bio-marker considered to be representative of health and well-being in old age, with studies consistently reporting that older adults grip strength itself predicts health-related outcomes such as premature mortality, disability, and other health-related complications among middle-aged and older adults (Ling et al., 2010; Rantanen et al., 2000). The finding that psycho-social constructs such as older adults' self-perceptions of age is related to stronger grip strength in old age is exciting as ultimately it suggests that older adults' self-perceptions of age are amenable to change via interventions. If we can increase older adults' self-perceptions of age, it may be possible that we also would increase older adults grip strength, leading to better health and functioning in older age.

For instance, Khotter-Gruhn & Hess (2012) recently demonstrated that self-perceptions of ageing can be adversely affected by negative age-stereotype priming. Results indicate that after activation of negative age-stereotypes, older adults who are considered to be in good health reported less satisfaction with their experience of

ageing, experienced an increased subjective age (felt older), and also reported an increased desire to be younger. This effect was more pronounced in those older adults who were considered to keep poorer health. Unfortunately, the effects of the positive age-stereotypes did not have the opposite effect of the negative age-stereotypes and were also associated with reduced self-perception of age measures. As the researchers used an explicit (priming stimuli is clearly visible to the participant) age-stereotype priming paradigm in which participants were presented with positive or negative images of older adults, the researchers hypothesise that these findings are likely due to "upward social comparisons." That is, the older adults who are in good health and feel positive about their perceptions of ageing, when shown a picture of other happy older adults, they may make a comparison to this positive group, placing their perception of their own age into perspective and as a result, no longer feel as positive about their own ageing experience. Consequently, it is important that alternative age-stereotype priming techniques are developed, as it is possible that other age-stereotype priming techniques may influence self-perceptions of age and therefore grip strength differently. At present, no previous research as examined whether the effect of implicit age-stereotype priming (which operates below the participant's level of conscious awareness) can influence self-perceptions of age, and therefore result in stronger grip strength.

3.4.2 Limitations

One limitation of the current work is that it is not possible to determine the direction of the relationship between older adults' self-perceptions of age and peak grip strength during the grasping task. It is possible that increases in grip strength are what cause an increase in older adults' positive self-perceptions of age. While this is possible, it does not seem likely, as previous research does not support this standpoint. Sargent et al. (2012) found that self-perceptions of age significantly predicted declines in physical functioning, but more importantly, that declines in physical function did not

significantly predict older adults' self-perceptions of age. This ultimately indicates that older adults' self-perceptions of age can have either a protective or exacerbating influence on the decline of physical functioning in old age.

3.4.3 Conclusions

The current study found that within a UK based sample of participants, older adults' self-perceptions of age scores were positively related to grip strength during a simple grasping task, an association not found within younger adults. This association between the self-perceptions of age and grip strength is independent of increasing age. The current findings create a theoretical foundation for future studies within the current thesis to examine the exact role that self-perceptions of age play when examining the effects of age-stereotypes upon the functional health of older adults (as measured by grip strength) using larger samples. Here, the results demonstrate that having a positive perception of your own ageing experience is likely to be a protective factor in maintaining functional health in older age. This means that improving self-perceptions of age could help to increase key measures of functional health, such as grip strength, keeping older adults more functionable healthy and independent for longer. The aim of the following study (Study 2) is to develop a priming paradigm which can be used to present implicit age-stereotyped prime words. Developing this priming paradigm will allow subsequent studies to determine whether the natural association between grip strength and self-perceptions of ageing in older adults would be affected by subliminal exposure to information (i.e., culturally valid age-stereotyped word primes) that can alter self-perceptions of age amongst older adults, and whether they also show better functional health, illustrated by grip strength performance on the same hand grip task.

Chapter 4: Study 2: The creation and evaluation of a bespoke implicit age-stereotype word priming paradigm

4.1 Introduction

Study 1 found that within a UK based sample of participants, older adults' self-perceptions of age scores were positively related to grip strength during a simple grasping task, an association not found within younger adults. Ultimately, these results highlight that having a positive perception of your own ageing experience is likely to be a protective factor in maintaining functional health in older age. This means that improving self-perceptions of age could help to increase key measures of functional health, such as grip strength, keeping older adults more functionally healthy and independent for longer. The aim of the current study is to develop a priming paradigm which can be used to present implicit age-stereotyped prime words that can be used in subsequent experimental studies to manipulate older adults' self-perceptions of age and grip strength levels. This will determine whether or not exposure to culturally valid age-stereotyped primes can alter older adults' self-perceptions of age and consequently their functional health, as measured by grip strength.

This study highlights three main methodological criticisms of previous implicit age-stereotype priming research. Firstly, previous research is limited in that studies adopting an implicit age-stereotype priming method rely on already existing age-stereotype prime words, which were created by Levy et al (2000) using a North American sample of participants. This is problematic, as while age-stereotypes across many western cultures do share some similarities in terms of their content, there are variations in the use of language to describe ageing (Lockenhoff et al, 2009). For instance, many American adjectives (such as "diseased" and "learned") were used as age-stereotype word primes and these are not necessarily used to describe old age in the

UK. It is therefore important that implicit age-stereotype priming develops culturally relevant age-stereotype prime words before implicitly priming these in order to ensure that these are representative of culturally popular age-stereotypes within the UK.

Secondly, a recent meta-analysis (Meisner, 2012) highlights that studies often lack a neutral priming condition, yet the ability to compare the effects of positive and negative primes against neutral primes is required to determine that changes in performance are due specifically to the positive or negative valence of the age-stereotyped word primes, and not some other characteristics of these stimuli. In addition, it provides a baseline against which to quantify the magnitude of negative versus positive age-stereotype primes.

Finally, in order for implicit (i.e., subliminal) priming to occur, the presentation duration of the age-stereotype word primes must allow encoding of the prime content but without awareness of the age-stereotype word primes. This creates a unique challenge for researchers using this particular method, as each individual has a different visual processing speed, and individual variation in these visual processing speeds increases in older age. This makes it difficult to present visual stimuli for durations that allow unconscious encoding of the content of the stimuli, which also account for individual's visual processing speed. The third limitation of previous research is that studies employing implicit age-stereotyped word primes have failed to account for this individual variation in visual processing speeds, and instead have adopted similar priming paradigms whereby the 'subliminal' word prime stimuli were flashed on a screen for one of only three possible durations (55, 66 or 110 ms) with inconsistent intervals between the presentation durations. These three categories, however, are unlikely to sufficiently account for the high degree of variation in age-related decline in visual processing speed (Wiegand, Töllner, Dyrholm, Müller, Bundesen, & Finke, 2014). It is possible that some participant's visual processing speed on computer based

priming tasks will fall somewhere between two presentation durations (i.e., somewhere between 66 and 110ms) as previous research has shown that whilst individuals visual processing speeds on computer-based word priming tasks can range from 51ms to 221ms (Bargh & Pietromonaco, 1982; Devine, 1989). Failing to accommodate the wide variation in visual processing speeds, as well as using inconsistent incremental changes between presentation durations of the stimuli, means that it is possible that the stimuli can be presented during priming tasks for a duration where participants report an inability to perceive the stimuli, but this may also be slightly too fast to allow the individual to encode / process the content of the stimuli optimally. This would mean that priming studies may have underestimated the effects of age-stereotyped word primes on older adult's abilities, but in addition, may also explain why some researchers have failed to replicate age-stereotyped word priming effects (Horton, Baker, Pearce, & Deakin, 2010).

To address these three methodological gaps in previous research, this methodological study was divided into three phases. Phase 1 aimed to develop a list of 10 negative, positive and neutral age-stereotype priming words using a UK based sample of participants. Phase 2 gives an overview of a two-step priming paradigm that could adapt the presentation duration of subliminal word primes to each participant's individual visual processing speed. I built upon a similar development procedure introduced by Levy et al. (2014), where the researchers used a wider range of stimuli presentation durations (70 - 201ms) in a task designed to assess the impact of positive age-stereotyped primes. However, this wider range of visual presentation durations still did not capture the increasing variation in visual processing speed found in older age, as previous research shows visual processing ability to range between 55 – 210 ms (Bargh et al, 1982), and also only focused on positive age stereotype primes. I therefore increased the range of presentation durations further, but more specifically tailored this

window to the increasing range in visual processing times with older age that is found in the literature (Devine, 1989; Wiegand et al, 2014). I then used a descending-limits paradigm to gradually reduce the presentation duration of the age-stereotyped word primes (with consistent intervals between each presentation duration) to find each participant's individual processing speed (i.e., the speed at which they are unaware of the word being presented). This means that during the priming phase the primes can then be tailored each individual visual processing speed. Finally, phase 3 aims to test the reliability of the implicit priming paradigm that was developed in phase 2 by checking that the age-stereotype word prime manipulations are in fact occurring below participants level of consciousness awareness (i.e., are in fact operating implicitly).

4.2 Phase 1: Developing UK based age-stereotype priming words

Previous research has developed a set of age-related self-stereotype prime words (Levy, 1996), however these were developed using a North American sample of participants and failed to include any neutral (control) words/condition. To address these limitations, the aim of the phase 1 was to develop a list of negative, positive, and neutral age stereotype prime words using a sample of UK based participants. To achieve this aim, we followed a similar procedure to that outlined by Benaji et al. (1993).

4.2.1 Method

4.2.1.1 Participants

Baker (1994) recommends that a pre-test experiment developing priming stimuli in preparation for a larger study should recruit a sample size that is 10-20% of the sample size for the actual study. As the current priming paradigm was to be used in future studies within this thesis, following these guidelines, G*power was used to guide sample size estimates for future studies within the current thesis. The largest sample size required in future studies of the current thesis was estimated at N=162 (study 3).

Following Baker's (1994) guidelines, 20 adults aged between 18-84 years (M = 48 , SD = 4.72, 75% female) were recruited to participate in phase 1.

4.2.1.2 Materials

Measuring the valence of the prime words. Consistent with previous research (Benaji et al, 1993; Levy, 2000) participants were asked to rate the valance of each adjective on a scale of 0 (very negative) to 10 (very positive).

Measuring how characteristic of ageing the prime words are. In order to ensure that the age-stereotype word primes are relevant to ageing, participants were asked to rate how characteristic of ageing each adjective is on a scale of 0 (very uncharacteristic) to 10 (very characteristic) of ageing.

4.2.1.3 Procedure

Step 1- Generating a list of negative, positive and neutral adjectives.

The procedure began with asking a group of 10 of the participants to generate a list of adjectives that they thought were "characteristic of ageing healthily" (positive age primes), and "characteristic of ageing poorly" (negative age primes). When creating the neutral list of adjectives, these 10 participants were asked to generate adjectives that were neither positive nor negative in valence, and which were not specific to ageing.

Step 2 – Rating each adjective.

This was followed by a new group of 10 participants rating the positive and negative adjectives (provided from phase 1) on two dimensions: how characteristic of ageing they seemed, using a scale of 0 (very uncharacteristic) to 10 (very characteristic), and how positive or negative they seemed on a scale of 0 (extremely negative) to 10 (extremely positive). For the neutral adjectives, the 10 participants were asked to rate how specific each of these words were to ageing on a scale of 0 (specific to ageing) to 10 (unrelated to ageing), and in terms of their valence on a scale from 0 (extremely negative) to 10 (extremely positive).

4.2.2 Results

The positive and negative adjectives that were selected as age-stereotype priming words were those which met the following conditions amongst all participants who rated them: (a) they were considered by the reviewers as characteristic of ageing healthily or poorly; (b) when asked to rate how positive or negative the adjectives were on a scale of 0 to 10, adjectives which were considered as positive were those rated as 7 or above, and the negative adjectives were those rated as 3 or below on the negative / positive scale. The neutral adjectives selected for the control condition were those that were rated as (a) unrelated to ageing (7 or above) and (b) neutral on the valence scale (between 4-6 out of 10).

The negative age-stereotype prime condition consisted of 10 words: *slow; senile; decrepit; frail; forgetful; dependent; immobile; impaired; weak; disabled.* The positive ageing prime also comprised 10 words: *independent; wise; active; alert; mobile; knowledgeable; insightful; adaptable; accomplished; engaged*. The neutral age-stereotype word prime consisted of 10 neutral words which were not related to ageing. These included: *impartial; usual; normal; standard; everyday; regular; average; representative; mainstream; neutral.*

4.3 Phase 2: Outline of the computer based priming method

The next phase of the current methodological study was to develop a computer based priming task which could present the age-stereotype prime words generated in phase 1 for durations which ensured the primes were presented implicitly (i.e., below participants level of conscious awareness), whilst still encoding the content of the primes. Most crucially, this method was designed to allow me to adapt the presentation duration of the prime words to account for the high degree of variation in visual processing speeds commonly found within older adult participants. As discussed in the introduction to this study, previous implicit age-stereotype priming research is limited

in that previously it has tended to focus on/use 3 presentation durations only (50, 100, and 150 ms, and 200 ms) with large intervals of 50ms between each presentation duration.

Phase 2 gives an overview of the two-step priming paradigm that was designed to present age-stereotyped word primes at presentation durations, which allowed for unconscious processing of the content of the age-stereotyped word primes, but that could also adapt the presentation duration of implicit age-stereotype word primes to account for each participant's individual visual processing speed. I built on a similar development procedure introduced by Levy et al (2014), where they used a wider range of stimuli presentation durations in a task designed to assess the impact of positive (but not negative) age-stereotyped primes. However, this wider range of visual presentation durations still did not capture the increasing variation in visual processing speed found in older age (and also only focused on positive age stereotype primes). In the current priming task, I therefore incorporated a wider range of presentation durations, but importantly, I but also specifically tailored this window of presentation durations to the increasing range in visual processing times with older age that is found in the literature (Bargh et al, 1982; Devine, 1989). I used a descending-limits paradigm to gradually reduce the presentation duration of the age-stereotyped word primes in order to find each participant's individual processing speed (i.e., the speed at which they are unaware of the word being presented), so that during the priming phase the primes can then be tailored their individual visual processing speed.

4.3.1 Step 1 – Identifying optimal presentation durations for each individual

Step 1 of the priming paradigm aimed to identify the optimal presentation duration for the age-stereotyped word primes, by accounting for the individual's own visual processing speed. The computer based priming task was created using PsychoPy V1.8 and started by presenting ten non-words which consisted of a string of letters,

either the letters ‘A’ or ‘L’, on a PC screen using a descending limits paradigm. As previous research has shown that individual’s visual processing speeds on computer-based word priming tasks can range from 51ms to 221ms (Bargh et al, 1982; Devine, 1989) the presentation durations of the non-word test primes were presented at gradually slowing speeds, with a small interval of 34ms between each speed between 51 to 221ms (i.e., 51ms, 85ms, 119ms, 153ms, 187ms, 221ms), and each non-word was followed by a backwards visual mask (ampersand symbols).

After completing each trial of presentation duration, participants were asked to rate how visible the non-words had been on a scale from 1 (*easily perceive content)* to 10 (*could not perceive any content*). This process continued using the next gradual decrease in presentation duration (e.g., the non-word primes appeared on the screen for a shorter time period). To ensure that the non-word primes remained below participants’ level of conscious awareness, and accounted for individual differences in visual processing speed, each participant’s optimal presentation duration was selected based on two criteria: Participants (1) rated the extent to which they could perceive the random letters above 8 out of 10 (where 10 - *could not perceive any content/letters*) and (2) accurately encoded the content of the letters by hitting the correct corresponding key (either A or L) seven or more times across the 10 trials.

4.3.2 Step 2 – Presentation of the age-stereotyped prime words

After identifying the optimum presentation duration for each participant in step 1, step 2 of the priming procedure refers to the experimental testing phase, where each participant’s optimal presentation speed was used to present the age-stereotyped word primes (generated in phase 1).

4.4 Phase 3 – Pilot testing the priming paradigm

As discussed in the introduction to the current chapter, in order for implicit priming to occur, stimuli (the age-stereotype word primes) must be presented for a

duration that allows participants to encode the content of the stimuli, but that also appears for a short enough duration that participants report an inability to consciously perceive the stimuli (e.g., report being unable to consciously see the prime). Phase 3 aimed to test the reliability of the implicit priming paradigm that was developed in phase 2. Consistent with previous priming research (Bargh et al 1982; Devine, 1989; Benaji et al, 1994), in order to check the age-stereotype word primes had been encoded successfully, but were operating below participants levels of conscious awareness, phase 2 performed checks on manipulations. These compared both response times and the accuracy of responses (indicative of successfully encoding the age-stereotype prime words) between presentation durations in which participants reported an ability to perceive the non-word primes, compared to the presentation durations in which participants reported being unable to perceive any non-word primes.

4.4.1 Method

4.4.1.1 Participants

When determining the sample size, I followed the same guidelines used in phase 1, which recommend a pre-test experiment developing priming tasks in preparation for a larger study should recruit a sample size that is 10-20% of the sample size for the actual study (Baker, 1994). As mentioned in phase 1, a G*power analysis was used to guide sample size estimates for future studies within the current thesis, revealing that the largest sample required in the current thesis was N=162 (study 3). Following Baker's (1994) guidelines, a new group of 20 older adults (65-87 years, M = 70 , SD = 5.87, 65% female) were recruited to participate in phase 3.

3.4.1.2: Materials

Screening. In addition to the Mini Mental State Exam (MMSE, Folstein & McHugh, 1975), participants completed a health questionnaire (please see appendix for further details). Participants were excluded from the study if they (1) scored less than

24/30 on the MMSE, (2) reported a neurodegenerative or eyesight disorders (e.g. any visual impairment which could not be rectified by glasses).

Measuring visibility of test primes. Ability to consciously perceive the non-word test primes was measured on a scale of 1-10 (where 1 represented "*I could clearly perceive the content*" to 10 which represented "*I could not perceive* any *content"*. Any score above 8 indicated that participants could not consciously perceive (e.g., visibly see) the non-word test primes presented on the PC screen.

Measuring response times. During the priming paradigm, participants were instructed to press either the 'A' or the 'L' key with their preferred hand as quickly as possible following the presentation of the non-word. Response times were measured by the priming paradigm in milliseconds (ms).

Measuring accuracy of responses. Participants ability to accurately encode the content of the non-word primes was measured by pressing the correct corresponding key (either A or L). When a non-word consisting of a string 'A' letters was presented, participants were asked to press the 'A' key. When a non-word consisting of a string 'L' letters was presented, participants were asked to press the 'L' key. Every correct response was awarded a score of 1 and any incorrect responses were awarded a score of 0. As there were 10 trials in the pilot priming procedure, the highest possible score was 10, with higher scores representing a higher number of correct responses.

4.4.1.2 Procedure

Step 1

On arrival to the lab, participants were asked to complete the MMSE and a short health questionnaire to screen for pathological decline which may impact their ability to perform the priming task (e.g., any visual impairment which could not be rectified by the individual wearing prescription glasses).

Step 2

Participants were then informed that they were taking part in a short PC-based task which aimed to investigate their visual processing speeds, and that the test is largely similar to one often used by opticians during a regular eye test. Participants were informed that a string of non-words which consist of either a string of 'A's' or 'L's' would appear in the middle of the PC screen for a very short duration of time. If participants saw a non-word consisting of a string letters containing 'A,' participants were instructed to press the corresponding 'A' key. If they believed they saw a non-word containing a string 'L's,' participants were asked to instead press the 'L' key. Should participants report they were unable to perceive or missed any non-words appearing on the screen, they were asked to take a guess and continue with the task. It was also explained to the participants that following this, they would be asked to complete a short questionnaire which asked them to rate the visibility of the letters on a scale from 0 (not visible at all) to 10 (clearly visible). This process would repeat itself six times, and each time the letters would appear on the PC screen for a shorter duration.

4.4.2 Results

Consistent with previous age-stereotype priming research (Stein et al., 2002; Levy et al, 2014) to check that manipulations using the pilot priming paradigm had been successful, I compared response times and accuracy of responses between presentation durations when participants reported being able to perceive the non-word test primes (i.e., visibly see the non-words) compared to when they reported being unable to perceive the non-word test primes.

Response times and visibility of the non-word primes

Participants response times was measured in milliseconds, and the ability to consciously perceive the non-word test primes was measured on a scale of 1-10 (where 1 represented "*I could clearly perceive the content*" to 10 which represented "*I could*

not perceive any *content."* As mentioned in the method above, any score below 8 indicated that participants could visibly see the content of the non-word primes, whilst a score of above 8 indicated that participants could not consciously perceive (e.g., visibly see) the non-word test primes presented on the PC screen.

A paired sample t-test was used to compare response times between presentation durations where participants were either able to visibly see, or unable to visibly see, the content of the non-word primes. Results show that response times did not differ ($t(19) = 0.094$, $p = 0.926$, Cohen's $d = 0.028$) indicating that the mean response time to choose the corresponding key (matched to the content of the non-word primes) did not differ between when participants consciously reported the ability to perceive the non-word prime and when they reported an inability to perceive the non-word prime content. See Figure 3.1.

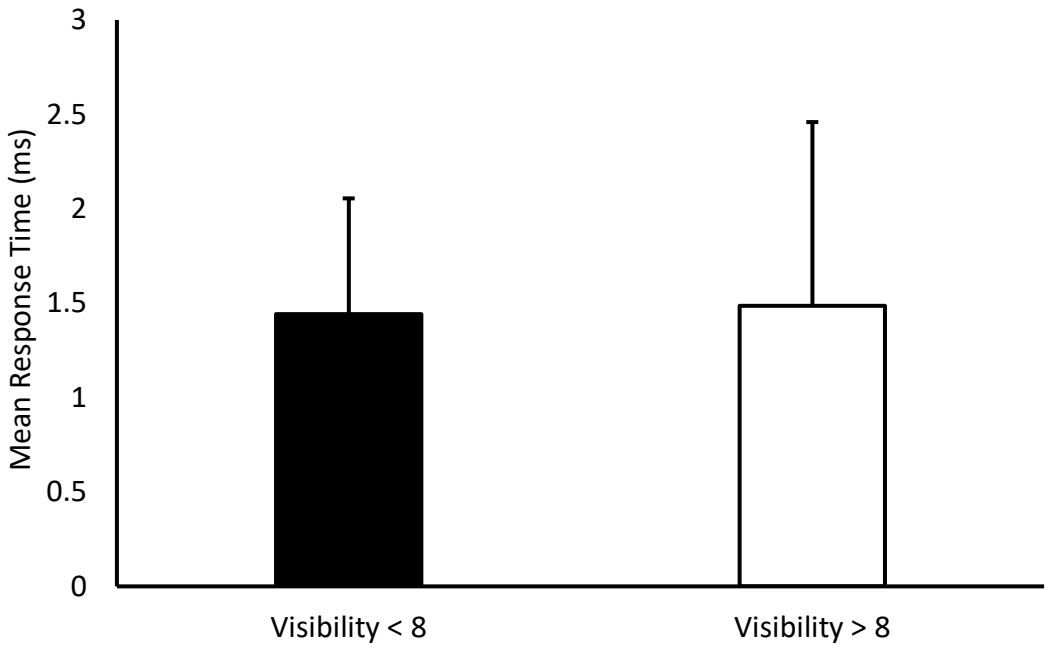


Figure 3.1

Mean ± standard deviation for response times across presentation speeds where participants reported ability to see the non-word test primes (visibility rating of less

than 8) compared to response times when participants reported being unable to perceive the non-word test primes (visibility of more than 8). (N = 20).

4.4.2.1 Accuracy and visibility of the non-word primes

Participants' ability to accurately encode the content of the letters in the non-word primes was measured by pressing the correct corresponding key (either A or L). Every correct response was awarded a score of 1 and any incorrect responses were awarded a score of 0. As there were 10 trials in the pilot priming procedure, the highest possible score was 10, with higher scores representing a higher number of correct responses.

I also compared the number of accurate responses between presentations durations where participants reported being able to either visibly see, or unable to visibly see, the content of the non-word primes. This was to ensure that participants were successfully processing the content of the primes at presentation durations that (1) allowed encoding of the content of the primes, whilst (2) reporting an inability to consciously perceive (i.e., visibly see) the content of the non-words.

A paired sample t-test showed that participants' accuracy scores did not differ ($t(19) = 0.046$, $p = 0.853$, Cohen's $d = 0.023$) between presentation durations when participants were able to either visibly see, or unable to visibly see the content of the non-word primes. Figure 3.2 illustrates this pattern.

These results indicate that even during presentation speeds in which participants reported being unable to perceive any content of the non-word primes, their accuracy in choosing the correct corresponding key (which matched the content of the non-prime word) was no less accurate than when participants reported the ability to perceive the content of the non-word primes. Ultimately these results demonstrate that even though participants could not report seeing any content of the non-word primes, they still successfully encoded the content of the non-word prime.

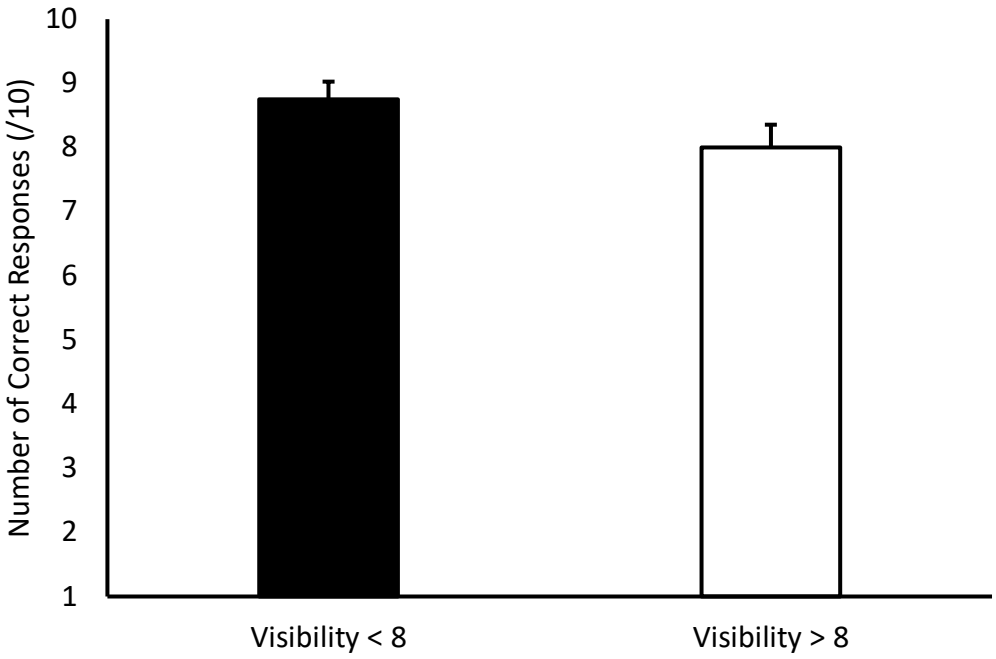


Figure 3.2

Mean number of correct responses ± standard deviation between presentation speeds where participants reported the ability to visibly see the non-word primes (visibility rating of less than 8) compared to when they reported the inability to visibly see the non-word primes (visibility of more than 8). (N = 20)

4.4.2.2 Results Summary

In summary, results demonstrate that response times and accuracy of participants' responses during the priming task were not significantly different between presentation durations when the participants reported visibility of the non-word primes compared to presentation durations when the participants reported being unable to consciously perceive the non-word primes. Taken together, these results suggest that the priming paradigm successfully allowed encoding of the non-word primes whilst also presenting the non-word primes at presentation speeds which operated below participants' level of conscious awareness.

4.4.3 Discussion

The introduction to the current chapter outlined three key limitations of previous priming research. The current chapter aimed to address these limitations by developing a new bespoke age-stereotyped word priming paradigm.

Phase 1 of the current chapter used a sample of UK based adults to generate a list of negative and positive age-stereotype word primes. By using UK based adults to generate this list, it ensured that the content of the age-stereotype word primes was reflective of popular UK based age-stereotypes. Most importantly though, phase 1 also developed a set of neutral word primes which were unrelated to ageing. When using the priming paradigm, this will allow me to compare the effects of the negative and positive age-stereotype prime words against the neutral prime words in order to ensure that any changes in performance following the priming task are specifically due to the valence of the negative and positive age-stereotype word primes (and will also allow the relative magnitude of the positive and negative effects to be compared to neutral).

Phase 2 of the current chapter outlined the new priming task which included a two-step process to present age-stereotyped word primes for a wider range of presentation durations and using a descending limits paradigm with smaller intervals between each presentation duration. This will allow me to gradually, and more closely match presentation durations of the age-stereotype prime words to each participants' visual processing speed. This development of the priming task means that a wider range of prime presentation durations can be incorporated into the task, thus accounting for the high degree of variation on older adults' visual processing speeds.

Finally, Phase 3 performed manipulation checks to test the reliability of the new bespoke age-stereotype word priming task by comparing the response times and accuracy of the responses (indicative of successfully encoding the age-stereotype primes words) between presentation durations in which participants reported an ability to perceive non-word test primes and presentation durations in which participants could

not perceive the non-word test primes. Results demonstrated that response times and accuracy of participants responses during the priming task were not significantly different between presentation durations when the participants reported visibility of the word primes compared to presentation durations when the participants reported being unable to consciously perceive the word primes. Taken together, these results suggest that the new bespoke priming paradigm, which presented the prime words for durations which were matched to the individuals' visual processing speed, successfully allowed encoding of the word primes whilst also presenting the word primes at presentation durations which operated below participants' level of conscious awareness.

These results ultimately demonstrate that the newly developed age-stereotype word priming task will be suitable to be used in subsequent studies of the current thesis to implicitly prime older adults with age-stereotyped words, so that I can measure the impact of these upon performance. The following chapter, Study 3, will move on to use the priming task outlined in phase 2, to present the age-stereotyped word primes developed in phase 1 and test the effects of these on measures of functional health in younger and older adults.

Chapter 5: Study 3: The Effects of Age-Stereotyped Word Primes on (a) Self-Perceptions of Age, and (b) Grip Strength During A Precision Grasping Task.

5.1 Introduction

Study 1 of the current thesis demonstrated a natural association between self-perceptions of age and grip strength (after controlling for age) and was found only within the sample of older adults. Study 2 developed a bespoke priming task to implicitly (subliminally) prime participants with UK culturally based age-stereotyped prime words. This bespoke priming method has been specifically developed to overcome regularly cited limitations in previous age-stereotype priming research. Study 3 aims to use this improved age-stereotype priming task to investigate whether the natural association between grip strength and self-perceptions of ageing in older adults (found in study 1) is affected by subliminal exposure to culturally valid age-stereotyped word primes. More specifically, I aimed to examine whether subliminal exposure to age-stereotyped word primes can alter (a) self-perceptions of age and (b) grip strength, in younger and older adults.

5.1.1 Age-stereotype development and operation

In Western societies, individuals are regularly exposed to age-stereotypes from advertising and the media. For instance, Age UK (2009) reported that 50% of adults over the age of 50 feel that the marketing of products targeted at them are patronising and stereotypical. While there has been a recent research focus on age-stereotypes, most of these studies have focused on the formation and development of age-stereotypes, but fewer have explored their effect on markers of older adults' health and well-being.

As discussed in the general introduction of this thesis, Burke (1981) showed that age-stereotypes are formed from approximately 6 years old, and often influence the

expectations of the ageing process (Seefeldt, Jantz, Galper, & Serock, 1997), with children from as young as 6 describing older adults as “frail” and “helpless”. Throughout adulthood, these age-stereotypes that were formed in childhood are thought to become further ingrained into our perceptions of old age, largely because ‘old’ is seen as an out-group, thus there is little need for a psychological defence against such age-stereotypes (Levy & Benaji, 2002). This concept has been evidenced by research that demonstrates middle-aged adults’ information recall regarding older adults is often reliant on age-stereotypes. For instance, age-stereotypes are dominant in comparison to our actual experiences (Levy, 1996), and often operate below an individual’s levels of consciousness (Levy, 1996).

Stereotype embodiment theory proposes that later in life, an individual often identifies as being ‘old’ after demarcations by a variety of arbitrary events, such as being offered a ‘concessioners’ price at the local cinema, or in the UK, the start of old age is often defined by the issuing of a state pension, between the ages of approximately 65-67 years old. Research (Levy, 1996; Levy 2009) suggests that these artificial demarcations of old age in fact contribute to the subjective onset of old age, where an individual recognises they have undergone the right of passage from old age being a distant construct (the out group) to old age being an existing state (now the in-group). This passage brings with it the investment of age-stereotypes with self-relevance because it brings identification with others who are also old (Levy, 2003). For instance, Rothermund (2005) has highlighted that attributes associated with the ‘typical old person’ tend to become incorporated into the older adults current and future self-views. In other words, at the point in which age-stereotypes are directed at oneself in older age, they can be classified as self-perceptions of age.

This process of age-stereotypes becoming self-relevant for older individuals is facilitated by their encounters with a plethora of societal cues, which indicate that they

are ‘old.’ These subtle cues that remind us of our age are prevalent because they are distinct from other forms of prejudice and discrimination. For instance, unlike racism and sexism, ageism does not tend to be proscribed by political correctness. While initially these cues of old age may be thwarted by an individual’s state of denial (e.g., refusal to wear glasses as it makes them appear older), the prevalence of these cues tends to overcome individual’s resistance (Levy, Banaji, 2002)

5.1.2 Age-stereotypes and their effects on older adults

Unsurprisingly, and as discussed in the general introduction to this thesis, previous research examining the effects of age-stereotype priming on older adults has demonstrated that age-stereotypes can have both a detrimental and beneficial impact on several domains of older adults functioning, such as: cognitive functioning, self-perceptions of own ageing experience, and some measures of physical health.

The vast majority of research examining the effects of age-stereotypes have focussed on cognitive ability. Early research investigated how memory performance was influenced by cultural stereotypes about memory, showing that memory scores and positive self-perceptions of age were positively correlated (Levy, 1994). This research demonstrated that mainland Chinese people held the most positive views towards ageing, followed by deaf Americans, with mainstream hearing Americans reporting the least positive views of ageing. Memory performance mirrored this pattern of results with mainland Chinese performing the best on the memory tasks and hearing Americans performing the worst.

Further age-stereotyped word prime research attempted to untangle whether age-stereotypes influenced memory, or memory influenced age-stereotypes (Levy & Langer, 1994). This was achieved by using a method of implicit priming, whereby age-stereotyped word primes were presented subliminally (at visual processing speeds faster than conscious awareness) on a PC screen (e.g., Levy et al., 2000). Performance on

numerous memory tasks was measured prior and post exposure to the subliminal word primes. Results showed that older adults exposed to negative age-stereotyped word primes performed worse than those exposed to positive age-stereotyped word primes on four memory tasks; immediate, delayed, learned, and photo recall tasks. Replication studies found similar effects on photo recall and dot location tasks (Stein, Blanchard-Fields, & Hertzog, 2002). Similar results have been further evidenced by studies using a stereotype threat paradigm, highlighting that activation of negative age-stereotypes resulted in significantly poorer performance on memory recall tasks (Hess & Hinson, 2006; Hess, Hinson & Statham, 2004; O'Brien & Hummert, 2006).

The effects of age-stereotypes are, however, not limited only to cognitive functions, as negative age-stereotypes have been shown to exert a detrimental influence on older adults' self-perceptions of age. Prior research has shown that self-perceptions of age can be a powerful predictor of physical health and longevity; those older adults reporting positive self-perceptions practice significantly more preventative health behaviours over a 20 year time-span (Levy & Myers, 2004), report better self-reported physical functioning (Levy, Slade, and Kasl, 2002), recover faster from disease and trauma (Levy & Myers, 2004; Levy, Slade, May, & Caracciolo, & Kasl, 2002), compared to those with negative self-perceptions of age. In addition to this, study 1 of the current thesis has demonstrated that older adults' self-perceptions of age significantly and positively correlate with grip strength during a grasping task. Grip strength is a valuable dependent variable because it is a key bio-marker of successful ageing which is linked to good physical health and longevity in older age (Ling et al., 2010; Rantanen et al., 2000).

It is unfortunate that older adults' self-perceptions of their own ageing experience are also in fact susceptible to the effects of age-stereotypes. Eibach, Mock & Courtney (2010) measured older adults' subjective age before and after exposure to

either negative or positive age-stereotypes in the form of word searches. The positive ageing word search puzzle contained words such as “wise” and “alert”, whilst the negative ageing word search puzzle contained words such as “feeble” and “diseased”. Results demonstrated that for those older adults who received the negative age-stereotype word search condition, subjective age significantly increased (i.e. participants felt older). Conversely, those older adults who received positive age-stereotype cross words, subjective age decreased, and participants reported feeling younger. Further results demonstrated that those older adults who were exposed to the negative age-stereotype crossword condition were more likely to report age-stereotypical attitudes towards moral traditions, and same sex marriage.

More recent research has since replicated similar findings. Khotter-Gruhn & Hess (2012) found that older adults’ self-perceptions of age could be reduced by negative age-stereotypes using a photo prime task. After the activation of the negative age-stereotypes (activated using photos which depicted ageing as a negative experience), both healthy older adults and those who were thought to be in poorer health report being less satisfied with their ageing experience (evidenced by lower self-perceptions of age scores) and also an increased desire to be younger. Those older adults in poorer health also reported that they felt they looked older after the negative age-stereotype priming condition.

Given that self-perceptions of age predict the likelihood of older adults engaging in preventative health behaviours, such as physical activity, and that study 1 of the current thesis reported a natural association between the older adults’ self-perceptions of age and grip strength, it comes as no surprise that age-stereotypes also influence older adults’ measures of functional health in older age.

Emerging research suggests that age-stereotyped word primes can also influence motor control in manual tasks. For example, Levy (2000) exposed older adults to

negative age-stereotypes, then collected samples of handwriting. Independent judges rated the same handwriting samples as appearing "shaky" and "deteriorated," in comparison to the samples collected from older adults who were exposed to positive age-stereotypes. Thus, the control of automized motor tasks also seems to be sensitive to age-stereotypes. Historically, the cause of declines in motor control tasks, such as walking speed, have been attributed to disease and changes in physical activity levels, but recent research demonstrates that tasks such as walking speed and balance are also sensitive to age-stereotypes (Bargh, Chen, & Burrows, 1996; Hausdorf, Levy & Wei, 1999). Hausdorf et al., (1999) electronically measured the swing time (how long a foot is off the ground) of healthy older adults, whilst walking along a 45m hallway, before participants were implicitly primed with either positive or negative age-stereotyped words. Participants then walked along the same 45m hallway, and swing time was re-measured. Results showed that whilst negative age-stereotyped word primes significantly reduced swing time (indicative of poor balance), those exposed to positive age-stereotyped word primes also demonstrated increased swing time, indicating improved balance. The authors claim the improvement in swing time was similar to that resulting from intensive physiotherapy interventions.

Recent research has shown that age-stereotype primes effect both older adults' self-perceptions of age, and physical functioning simultaneously, and that the pattern of results within these two variables mirror one another. For instance, Stephan et al (2012) has shown that increases in older adults' self-perceptions of age are accompanied by increased grip strength. Stephan et al (2012) measured participants grip strength levels during a power grip task (a cylinder-shaped grasping action that resembles the way we grip a lever to manipulate it) before and after completing a social comparison priming paradigm, This paradigm involved presenting older adults with information about how useful and important hand grip strength is in predicting longevity and mortality rates.

Participants were then given positive feedback regarding their performance on the same hand grip task compared to same-aged peers. Results demonstrated the older adults who were manipulated to feel positively about their performance in comparison to same-aged peers experienced an increase in self-perceptions of their own ageing, which were simultaneously accompanied by increased measures of maximum grip strength. This suggests that older adults' self-perceptions of age may mediate the effects of age-stereotype measures on physical health and performance.

One key limitation of Stephan et al (2012) is that whilst he is the first to examine the effects of age-stereotypes on self-perceptions of age and grip strength, it is limited in that it only considers one particular grasping action (a power grip task). This is problematic as motor control research has shown that there are numerous different grasping actions which are required to perform daily living activities. One other such grasping action is a precision grip task which requires individuals to use predominantly the thumb and index finger to interact and lift objects (Carmeli, Patish, & Coleman, 2003). Precision grip tasks actually show the most severe age-related changes (Carmeli et al, 2003) and the ability to perform a simple precision grip task is essential for many everyday tasks that are often required to be able to remain independent and fully functional, whilst living at home. For instance, a precision grasping ability is required to correctly eat from a spoon, drink from a glass, and write with a pen (Carmeli et al, 2003). These types of grasp require precise control of the moments produced by the digits that act upon the handled object. If this control is impaired, the drink can be spilled, the food could make a mess, and in the case of Levy's (1990) early work, handwriting could become illegible. Yet, at present, little to no research has considered how age-stereotypes can influence this particular grip strength task.

One other study has also examined the effects of age-stereotypes upon both self-perceptions of age, and physical functioning measures. Levy et al, (2014) measured

physical function and self-perceptions of age were assessed at seven time points over an 8-week period. Physical function was assessed by (a) time to walk eight feet, (b) time to rise from a chair and return to seated position, and (c) the ability to stand side by side in semi tandem and tandem position for 10s. They found that performance on all measures of physical function and self-perceptions of age significantly increased following the positive age-stereotyped word primes, with the benefits lasting approximately three weeks after completing the last intervention session. Using path analysis, the researchers showed that the positive age-stereotyped word primes strengthened participants positive self-perceptions of age, which in turn improved physical performance, indicating that self-perceptions may be a potential mechanism to explain the effects of age-stereotypes on physical function. Taken together, these two findings suggest that self-perceptions of age may be a potential mechanism to explain the effects of age-stereotypes on physical function.

5.2 Some Unanswered Questions

The previous research outlined in the above sections demonstrates that positive and negative age-stereotypes do play an important role in the level of functional health older adult's experience. The same previous research, however, has both theoretical and methodological limitations. (1) Previous research investigating the effects of age-stereotypes upon older adults' self-perceptions of age have focused on using explicit age-stereotype priming paradigms and have overlooked implicit priming paradigms. Investigating the effects of age-stereotypes which are implicitly primed is important as in daily living, the vast majority of age-stereotypes older adults encounter often operate below an individual's level of consciousness (Eibach et al, 2010; Khotter-Gruhn et al, 2012).

(2) Previous literature on the effects of implicit age-stereotyped word primes has focussed on time-based measures of functional health (e.g., time taken to rise from

seated position) or walking speeds (e.g., swing time), leaving unanswered questions surrounding important performance-based measures, such as grip strength. In particular, whether age-stereotypes effect grip strength during a precision griping task which has been shown to experience the most age-related changes (Carmeli et al, 2003). Grip strength is required to perform an array of daily living tasks (Simard et al., 2012), and is considered to be a key marker of successful ageing which predicts nursing home admission, and health related outcomes such as disability (Rantanen, Volpato, Ferrucci, Heikkinen, Fried, & Guralnik, 2003) and mortality (Volaklis, Halle, & Meisinger. 2015).

(3) Whilst previous research has shown age-stereotypes to influence both older adults' self-perceptions of age and grip strength, to date, no previous research has examined whether, and if so how, self-perceptions of age impact the effects of age-stereotype word primes.

Regarding methodological limitations, as discussed in detail within the previous chapter (Study 2), previous implicit age-stereotype priming research also been criticised for (a) failing to include a crucial neutral priming condition, which would allow for comparisons of the effects of positive and negative primes against neutral primes (Meisner, 2012). (b) 6 out of 7 studies that do adopt an implicit age-stereotype word prime paradigm have been conducted in the USA (and from very few research institutes), failing to examine whether the effects of age-stereotype word primes are consistent across different countries, cultures, and institutions (Meisner, 2012). (c) Finally, a key limitation is that most previous priming studies employing implicit age-stereotyped word primes have adopted similar priming paradigms whereby the 'subliminal' word prime stimuli were flashed on a screen for one of only three possible durations (116, 66, & 56 ms). These three categories, however, are unlikely to sufficiently account for the high degree of variation in age-related decline in visual

processing speed (Wiegand, Töllner, Dyrholm, Müller, Bundesen, & Finke, 2014), which may have underestimated the effects of age-stereotyped word primes on older adults' abilities.

5.3 The current chapter

Over three separate analyses, the present study aimed to advance previous research from a theoretical aspect by investigating whether implicit age-stereotype word primes would influence older adults' (a) self-perceptions of age and (b) health, more broadly, as informed by grip strength during a precision grasping task. Grip strength is considered to be a performance-based measure of physical functioning (Davis, Ross, Preston, Nevitt & Wasnich, 1998), and more crucially, a key measure for successful ageing, as it is a good predictor of nursing home admission and health related outcomes such as disability (Rantanen et al., 2010) and mortality (Ling et al., 2010). (c) Furthermore, as self-perceptions of age have been suggested as a potential mechanism by which positive age-stereotyped word primes increase physical functioning (Levy et al., 2014), I also aimed to investigate whether self-perceptions of age mediate the effects of age-stereotyped word primes on older adults' grip strength.

In order to achieve these aims, I will use the new age-stereotype priming task which was developed in the previous chapter (Study 2) and addresses the three methodological gaps in previous research which were outlined in the previous section.

Study 3 advanced the following hypotheses: (1) According to stereotype embodiment theory (Levy, 2009), younger adults' self-perceptions of age and grip strength would remain unaffected by the age-stereotyped word primes as these are only personally relevant to the 'old'; (2) Priming older adults with negative age-stereotyped word primes would decrease self-perceptions of age, with the opposite effects found with positive age-stereotyped word primes, and no effects with neutral word primes; (3) Priming older adults with negative age-stereotyped word primes would decrease grip

strength levels, with the opposite effects found during the positive age-stereotyped word primes, and no effects with neutral word primes; and (4) Older adults' self-perceptions of age would mediate the effects of age-stereotyped word primes on grip strength levels.

5.4 Method

5.4.1 Participants

A power analysis using G*Power (Faul, Erdfelder, Buchner, & Lang, 2009) was performed to calculate the sample size needed when performing a mixed design ANOVA in order to detect significant main effects and interactions between the (BS) variables (age group and age-stereotype prime condition) and the (WS) variable (time of measurement).

When using G*Power, the F-test family was chosen, and the 'ANOVA Repeated measures, between factors test' (mixed ANOVA) was chosen. A previous meta-analysis by Lamont, Swift and Abrams (2015) considering the effects of age-stereotypes on physical activity, suggests that the average effect size of age-stereotype primes on physical functioning tasks is an effect size of around 0.32. I therefore calculated my sample size based on a medium effect size of 0.32. Probability was set a 0.05 and power level was selected at the recommended 0.8 level (Cohen, 1998). The number of groups was inputted as 6 (negative, positive and neutral priming conditions for both younger and older adults), and the number of measures was inputted as 2 (prior to and post priming). G*power informed that a sample size of 162 participants would be required.

With this in mind, 81 older adults (60-89 years, M = 73.08, SD = 6.88, 58% female) and 81 younger adults (18-27 years, M = 22.83, SD = 3.34, 68% female) were recruited to participate in the study. Younger adults were recruited using a Heriot-Watt University Student Research Participation Scheme in exchange for course credits. After study 1, when older participants (all of whom were exclusively recruited from fitness

classes) out-performed the younger adults on a grasping task, I widened the recruitment for the current study to recruit a sample of older adults from a wider range of sources. In this case, older adults were recruited from local activity classes in the Edinburgh and West Lothian district such as: a walking group, a seated exercise class, a bingo group, a reading group, a genealogy group, and the University of the Third Age. I distributed fliers advertising the study via voluntary response. As it was myself who distributed these fliers it allowed me to ensure participants met the inclusion before attending any lab-based testing sessions. Only 1 participant was excluded from participating in the study because they self-reported a neurodegenerative disorder which caused a tremor in their predominant hand. For full exclusion criteria, please see the screening subsection below.

5.4.2 Materials and Equipment

Screening. In addition to the Mini Mental State Exam (MMSE, Folstein & McHugh, 1975), participants completed a health questionnaire. Participants were excluded from the study if they: (1) scored less than 27/30 on the MMSE, (2) reported a neurodegenerative, movement or eyesight (which could not be corrected by prescription glasses) disorder, or (3) were taking medications that may cause tremors during a grasping action.

Self-perceptions of age. Self-perceptions of age were measured using the Philadelphia Moral Geriatric Scale (Lawton, 1975). This was administered and scored following identical instructions outlined in study 1. E.g., Items were rated on a 5-point scale (ranging from 1- strongly disagree to 5- strongly agree (higher scores indicate greater satisfaction with their own ageing experience). The subscale consists of items such as: “As I get older, things are (better, worse or the same) as I thought they would be”. The Cronbach’s alpha (internal consistencies) for this measure were .68 and .71 for pre-test and post testing measures.

Grip Task. Grip strength was measured in newtons in the same way as study 1: using a single 6-axis force sensor (Nano 17 transducer, ATI industrial automation, NC). Each object that participants lifted had a plastic mount on the centre of its top surface, containing the force sensor. Participants used this handle to grip and lift the object with their thumb and index finger on a pair of textured finger pads with a diameter of 25mm. During practice trials, participants were asked to grasp a small cube, and during test trials a small cylinder was used. Both objects were made from black plastic, and tailored to a height of 7.5 cm, and weight of 200g. Grip force is commonly known as 'grip strength' across domains of health and well-being literature, thus herein referred to as grip strength. Full details of the data pre-processing procedure can be found at https://sites.google.com/site/obintlab/wiki/data-processing.

Implicit age-stereotyping priming paradigm.

Participants were subliminally exposed to the positive, negative or neutral age-stereotyped prime words on a computer screen, using the improved priming paradigm (created using PsychoPy V1.8) that was detailed in the previous chapter (study 2). To address criticisms that previous priming paradigms did not account for the high variability in older adults' visual processing speeds (Wiegand et al., 2014), and thus to ensure that the priming stimuli were encoded below each participant's level of conscious awareness, I developed a two-step priming task.

Step 1 identified the optimal presentation duration for the age-stereotyped word primes, based on individual visual processing speeds. Step 2 of the priming procedure was the actual experimental testing, which used each participant's optimal presentation speed to tailor the presentation of the age-stereotyped negative and positive word primes/conditions. Crucially, the task also included a neutral word prime condition to allow (a) certainty that the valence of the negative and positive age-stereotype word primes were responsible for any changes in performance and (b) provided a baseline to

quantify exact changes in self-perceptions of age and grip strength following the priming intervention. For a full description of priming paradigm and its development, please see chapter 4, study 2.

5.4.3 Procedure

Phase 1 - Screening. On arrival, participants were told that they were participating in a study which measured their visual processing speeds as well as their ability to focus their attention during a computer based task.

Participants randomly assigned to either the positive, negative, or neutral age-stereotyped prime condition. To ensure that the MMSE, health questionnaire and measures of participant's perceptions of own ageing were not acting as age primes themselves, participants were asked to complete the measures either before or after the implicit stereotype prime intervention in a counterbalanced order. All participants were informed that they were going to be asked to participate in a two-step attention task, one that is similar to that which they complete during routine eye tests. Step 1 would measure their visual processing speed, whilst step 2 would measure their ability to focus their attention on a computer based task.

Phase 2 - Practice trials (without primes). All participants were asked to complete 5 practice trials of the grasping task to ensure that participants understood the instructions. Participants were asked to lift the cube "*straight upwards, with your thumb and index finger on the handle, in a smooth and confident fashion, around 5cm off the table, and aim to hold it steady without exerting unnecessary effort.*" An initial auditory sound indicated to participants to begin the grasping task by lifting the cube from the lift-off pad, and after having held the object for 6 seconds, a second auditory sound signalled to participants to lower the object back down.

Phase 3 - Baseline grip strength trials. To gain a baseline measure of each participant's grip strength, they completed 5 trials of grasping the small cylinder, with a 30-second recovery period between each trial.

Phase 4 - Selecting prime presentation speed using step 1 of the new priming method. Participants then completed step 1 of the priming paradigm (for details see the implicit age stereotyping priming paradigm section of the method), which determined the optimal duration of word prime stimuli for each individual in order for word primes to be encoded, but below conscious awareness. Participants were told that this step in the task was measuring their individual visual processing speed.

Phase 5 - Implicit age-stereotyped word priming intervention. Participants then completed step 2 of the implicit age-stereotype priming intervention. In this step, participants were informed that the task was measuring their ability to remain focused on a computer based task. Similar to that of Levy (2014), 10 negative, 10 positive or 10 neutral age-stereotyped word primes were flashed one at a time, in randomised order, on the PC screen, at each participant's optimal presentation speed. Each age-stereotype word prime appeared twice, so participants completed a total of 20 age-stereotype word prime trials. Participants were reminded that they may perceive a very quick flash appearing on the PC screen. Each age-stereotyped word prime appeared on the PC screen above or below a bulls-eye, and participants were then asked to respond by either pressing an arrow up or down key on the keyboard to indicate whether they perceived a flash above or below the bulls-eye. Participants were reminded to focus on the experiment and to respond as swiftly but accurately as they could. Following the priming intervention, participants were asked what they had seen on the screen. Responses indicated that they were unaware of the implicit-intervention content, which suggests that there was not an increase in awareness during the implicit prime intervention.

Phase 6 - Grip strength measurement post- age-stereotype priming intervention. To re-assess grip strength following completion of the implicit priming procedure, participants were then asked to complete the same grasping task as performed in the baseline trials (5 trials).

Phase 7 – Debriefing. After testing was completed, participants were debriefed regarding the full aims of the study.

5.5 Results

5.5.1 Descriptive statistics

Self-perceptions of age scores were measured using the Philadelphia Moral Geriatric Scale (Lawton, 1975). Scores could range from 0-25, with higher scores representing positive perceptions of one's own ageing experience. The peak grip strength levels were measured in Newtons, and the value on the first lift of the test object were examined. In the current study, these were averaged within each prime condition (positive, neutral, negative), age group (younger, older), and time of testing (baseline v post-priming grip strength).

Descriptive statistics highlight that grip strength levels showed a trend to be lower for the older adults in comparison to the younger adults. Consistent with the descriptive statistics in study 1, the older adults in the current study also showed a trend to report marginally higher self-perceptions of age (representing more positive views of their own ageing experience) in comparison to the younger adults, although, this difference was not statistically significant. Study 1 recruited older adults from only Edinburgh-based exercise classes, and so likely captured a sample of very healthy / physically fit older adults. The current study, on the other hand, attempted to recruit older adults from a wider range of activity classes that included more than just exercise classes, including less physically active classes such as book reading clubs and genealogy groups. It is possible that this overall trend persists due the two studies

incorporating self-selected samples from voluntary participation. This pattern of results will be discussed in more detail in the discussion section. The descriptive statistics for self-perceptions of ageing and grip strength for each age group is shown in Table 4.1.

Table 4.1

Descriptive Statistics for Younger and Older Adults' Mean Self-Perceptions of Age Scores and Peak Grip Strength (N = 162).

	Younger Adults	Older Adults
Mean Self-Perception of Age[a]	17.037 ± 2.133	18.383 ± 2.531
Mean Peak Grip Strength[b]	12.415 ± 1.380	12.264 ± 1.940

Note. Values shown = mean ± standard deviation.

[a] Scored out of a total of 25. Higher scores represent more positive self-perception of own aging experience.

[b] Measured in newtons. Higher scores represent higher grip strength.

5.5.1.1 Analysis A: Effects of age-stereotypes on self-perceptions of age

Descriptive statistics for self-perceptions of age, across both age groups (younger and older adults), prime condition (negative, positive and neutral priming) and time of measurement (baseline and post priming), can be seen in Table 4.2.

Table 4.2:

Descriptive Statistics for Self-Perceptions of age, Older and Younger Adults, at Baseline and Post Age-Stereotype Priming (N=162).

		Younger Adults		Older Adults	
	Valence	Baseline	Post Priming	Baseline	Post Priming
Mean Self-perception of age [a]	Negative age-stereotyped prime	16.824 ± 2.001	16.675 ± 2.646	18.332 ± 2.782	12.781 ± 2.251
	Positive age-stereotyped prime	16.301 ±1.561	16.998 ± 2.100	17.944 ± 2.304	20.108 ± 2.299
	Neutral prime	17.987 ± 2.839	17.467 ± 1.879	18.875 ± 2.507	18.042 ± 2.856
	Overall	17.037 ± 2.133	17.046 ± 2. 208	18.383 ± 2.531	15.643 ± 2.802

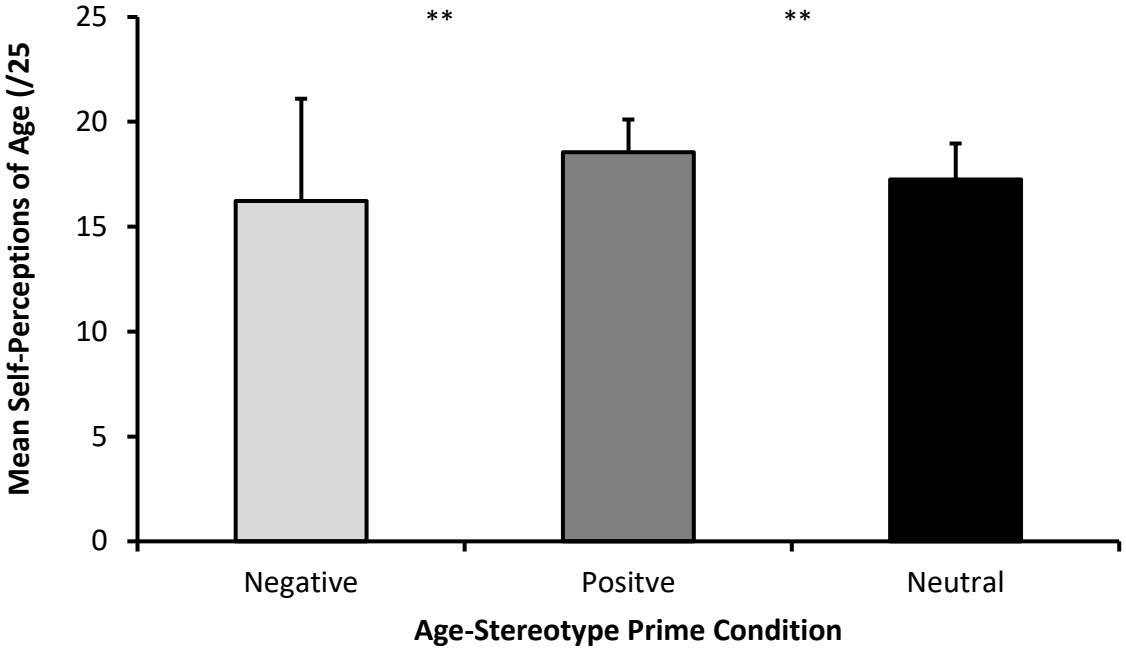
Note. Values shown = mean ± standard deviation.

[a] Scored out of a total of 25. Higher scores represent more positive self-perception of own aging experience.

A mixed design ANOVA was conducted with Age Group (2: old and young adults) and Prime Condition (3: positive, negative and neutral) as between-subject factors and Time of Measurement (2: baseline vs post-priming) as the within-subject factor, to investigate the effects of prime condition on self-perceptions of age. Results found that the main effect of Age Group was non-significant ($F(1, 159) = 2.753$, $p = 0.0763$ $\eta p^2 = 0.03$), nor did the main effect of Time of Measurement reach statistical significance ($F(1,159) = 0.777$, $p = 0.747$, $\eta p^2 = 0.02$). Prime Condition did, however, reach statistical significance ($F(1,159) = 4.873$, $p = 0.001$, $\eta p^2 = 0.17$). Post-hoc t-tests revealed that self-perceptions of age in the negative condition were significantly lower in comparison to the self-perceptions of age in the positive age-stereotype prime condition ($t(26) = 3.701$, $p = 0.002$, Cohen's $d = 0.353$) and the neutral priming condition. Furthermore, self-perceptions of age in the positive age-stereotype prime condition were significantly higher than in the neutral prime condition ($t(26) = 3.701$, p

= 0.002, Cohen's d = 0.461). These results are illustrated by Figure 4.1.

There were no significant two-way interactions between Prime Condition and Age Group ($F(1,159) = 0.156$, $p = 0.718$, $\eta p^2 = 0.00$), Age Group and Time of Measurement ($F(1,59) = 0.186$, $p = 0.908$, $\eta p^2 = 0.00$) or Time of Measurement and Prime Condition ($F(1,159) = 2.543$, $p = 0.091$, $\eta p^2 = 0.04$).



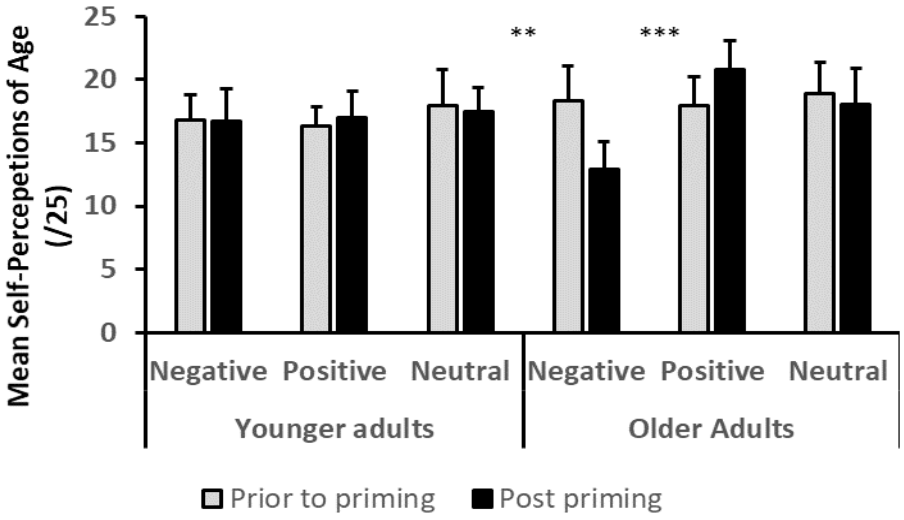
*** p<0.01*

Figure 4.1

Mean Self-Perceptions of age ± standard deviation for each age-stereotyped prime condition (N = 166).

Supporting both hypotheses 1 (that age-stereotype priming would not affect the younger adults self-perceptions of age) and hypothesis 2 (that priming older adults with negative age-stereotyped word primes would decrease self-perceptions of age, with the opposite effects found with positive age-stereotyped word primes, and no effects with

neutral word primes), a significant 3-way interaction was found between Time of Measurement, Age Group, and Prime Condition ($F(1,159) = 13.875$, $p = 0.001$, $\eta p^2 = 0.36$). This indicates that the pattern of self-perception of age scores differs between baseline and post priming for older and younger adults, and this pattern also differs between age-stereotype priming conditions. Post hoc t-tests using the Bonferroni correction (adjusted alpha = 0.008) revealed that following the negative age-stereotype prime condition, self-perceptions of age significantly decreased in comparison to baseline for older ($t(26) = 3.565$, $p = 0.002$, Cohen's $d = 0.461$), but not for younger adults ($t(26) = 1.389$ $p = 0.154$). In addition, following the positive age-stereotyped word prime condition, older adults' self-perceptions of age significantly increased ($t(26) = 5.652$, $p = 0.000$, Cohen's $d = 0.592$) in comparison to baseline, while younger adults' self-perceptions were unaffected ($t(26) = -1.453$, $p = 1.547$). Finally, following the neutral prime condition, self-perceptions of age did not change for older ($t(26) = 0.874$, $p = 0.203$, Cohen's $d = 0.178$) or younger ($t(26) = 0.851$, $p = 0.263$) adults. See



*** $p<0.001$ ** $p<0.01$

Figure 4.2

Mean Self-Perceptions of Age scores ± standard deviation for Older and Younger Adults, Prior to and Post Age-Stereotyped Priming Intervention (N = 166)

5.5.1.2 Analysis B: Effects of age-stereotypes on grip strength.

Previously, study 1 of this thesis demonstrated that older adults' self-perceptions of age significantly positively correlated with peak grip strength levels during a precision grasping, independent of age. Analysis A of the current study further demonstrates that older adults' self-perceptions of age can be experimentally manipulated by implicit age-stereotype word primes. For instance, older adults' self-perceptions of age were significantly reduced by exposure to negative age-stereotypes. Conversely, exposure to positive age-related word primes significantly increased self-perceptions of age. Finally, exposure to neutral word primes elicited no significant changes in older adults' self-perceptions of age.

Analysis B now aims to address hypothesis 3 of the current study, investigating whether priming older adults with negative age-stereotyped word primes would decrease measures of peak grip strength, with the opposite effects found with positive age-stereotyped word primes, and no effects with neutral word primes.

Descriptive statistics for grip strength, across both age groups (younger and older adults), prime condition (negative, positive and neutral priming) and time of measurement (baseline and post priming), can be seen in Table 4.3.

Table 4.3

Descriptive Statistics for grip strength in Older and Younger Adults, at Baseline and Post Age-Stereotype Priming (N=166).

		Younger Adults		Older Adults	
	Valence	Baseline	Post Priming	Baseline	Post Priming
Grip Strength (N/s)[a]	Negative age-stereotyped prime	12.075 ± 3.574	12.342 ± 3.297	14.009 ± 4.612	9.291 ± 5.734
	Positive age-stereotyped prime	12.997 ± 2.916	11.889 ± 2.740	12.990 ± 2.680	15.983 ± 5.602
	Neutral prime	12.173 ± 1.640	12.285 ± 2.716	12.793 ± 4.384	12.630 ± 3.010
	Overall	12.415 ± 2.710	12.172 ± 2.917	13.264 ± 3.892	12.968 ± 4.843

[a] Measured in Newtons. Higher scores represent greater grip strength.

A mixed design ANOVA with Age Group (2: old and younger adults) and Prime Condition (3: positive, negative and neutral) as between-subjects factors, and Time of Measurement (2: baseline vs post-priming) as the within-subjects factor was performed to compare grip strength levels across age-stereotype prime condition for older and younger adults, between baseline and post-priming. Results found no main effects of Age Group ($F(1, 165) = 6.726$, $p = 0.091$, $\eta p^2 = 0.09$), Prime Condition ($F(1,165) = 3.830$, $p = 0.380$, $\eta p^2 = 0.07$) or Time of Measurement ($F(1,165) = 0.735$, $p = 0.262$, $\eta p^2 = 0.01$).

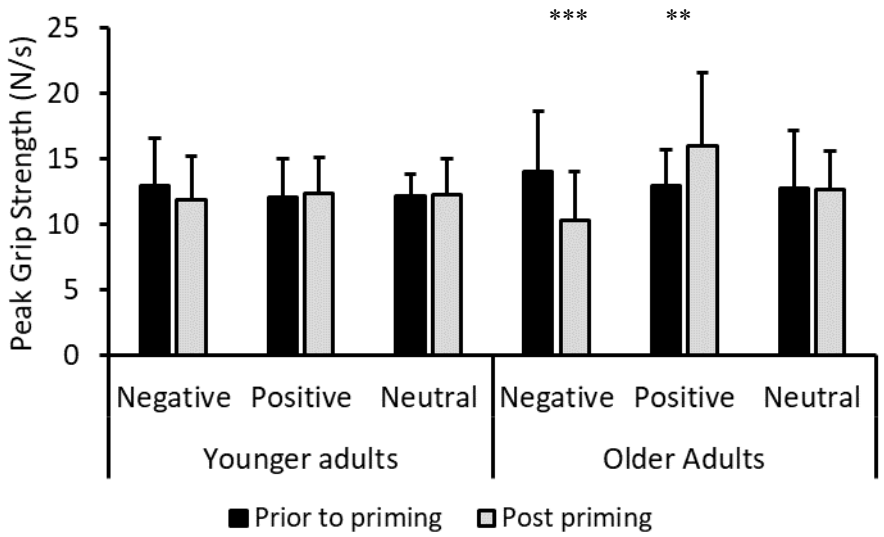
The Prime Condition by Age Group interaction was not statistically significant ($F(1,165) = 0.753$, $p = 0.871$, $\eta p^2 = 0.00$), nor was the Age Group by Time of Measurement interaction ($F(1,165) = 0.157$, $p = 0.972$, $\eta p^2 = 0.00$). There was however a significant 2-way interaction between Time of Measurement and Prime Condition ($F(1,165) = 13.787$, $p = 0.001$, $\eta p^2 = 0.31$). Post hoc t-tests using the Bonferroni correction revealed that grip strength significantly increased after receiving the positive age-stereotyped word prime condition ($t(53) = 4.735$, $p = 0.000$, Cohen's $d = 0.17$)

compared to baseline. Similarly, grip strength decreased after the negative age-stereotyped word prime condition (t(53) = -3.748, p = 0.001, Cohen's d = 0.23), with no significant change in grip strength following the neutral word prime condition (t(53) = 0.498, p = 0.621, Cohen's d = 0.00).

Supporting hypotheses 3 (that priming older adults with negative age-stereotyped word primes would decrease grip strength, with the opposite effects found with positive age-stereotyped word primes, and no effects with neutral word primes), a significant 3-way interaction was found between Time of Measurement, Age Group, and Prime Condition (F(1,159) = 12.423, p = 0.001, ηp^2 = 0.36). This indicates that the pattern of grip strength levels differs between baseline and post priming for older and younger adults, and this pattern also differs between age-stereotype priming conditions. Post hoc t-tests using the Bonferroni correction revealed that the effects of age-stereotyped primes on grip strength mirrored the pattern of results found for self-perceptions of age in analysis A; following the negative age-stereotyped word prime condition, peak grip strength for the older adults significantly decreased compared to baseline (t(26) = 3.742, p = 0.002, Cohen's d = 0.71), and did not significantly change for younger adults (t(26) = 1.601 p = 0.149, Cohen's d = 0.07). Following the positive age-stereotyped word prime condition, older adults' peak grip strength significantly increased (t(26) = 6.332, p = 0.000, Cohen's d = 0.70) compared to baseline, while the younger adults' peak grip strength was unaffected (t(26) = -1.233, p = 0.185, Cohen's d = 0.07). Finally, following the neutral prime condition, peak grip strength levels did not significantly differ from baseline for older (t(26) = 0.979, p = 0.634, Cohen's d = 0.02) or younger (t(26) = 0.923, p = 0.223, Cohen's d = 0.05) adults (see Figure 4.3).

Further post hoc analysis for the 3-way interaction revealed that within the older adults, the decrease in grip strength following the negative age-stereotype prime condition was significantly larger than the increase in grip strength following the

positive age-stereotype prime condition (t(53) = 3.271, p = 0.001 Cohen's d = 0.70). For the younger adults, however, the change (i.e., none) in grip strength following the negative prime condition did not significantly differ from the change (i.e., none) in grip strength following the positive prime condition (t(53) = -1.461, p = 0.990 Cohen's d = 0.01). This pattern of results indicates that the negative primes have a larger effect on older people's grip strength than the positive primes.



*** $p<0.001$ ** $p<0.01$

Figure 4.3

Mean Grip Strength Levels ± standard deviation for Older and Younger Adults, Prior to and Post Age-Stereotype Priming Interventions (N = 166)

5.5.1.3 Analysis C: Self-perceptions of age mediate the age-stereotyped primes and grip strength relationship

Analysis A shows that age-stereotyped word primes affect older adults' self-perceptions of age. Analysis B further showed that age-stereotyped word primes also affect older adults' grip strength; demonstrating a similar pattern of results. For instance, following the negative prime condition, both older adults' self-perceptions of age, and grip strength significantly decreased, whilst following the positive prime

condition, both self-perceptions of age and grip strength levels increased. Finally, the neutral age-stereotype priming condition elicited no effect on either self-perceptions of age or grip strength. The aim of analysis 3 is to address hypothesis 4 of the current study; to examine whether older adults' self-perceptions of age mediate the effects of age-stereotypes.

Mediation analysis was conducted to test the hypothesis that self-perceptions of age would mediate the effect of age-stereotyped word primes on grip strength levels. This was performed using the bootstrapping methodology (Preacher & Hayes, 2004), according to which the 95% confidence intervals must not contain zero in order to have a mediation effect. The SPSS macros PROCESS developed by Hayes (2013) was used to conduct bootstrapping (1,000 resamples) analysis (Black & Reynolds, 2013; Preacher & Hayes, 2008).

Consistent with the use guidelines for a simple mediation model (Hayes, 2013) when using the SPSS extension programme macros PROCESS, the Independent variable of prime condition was a binary variable (coded as 0 = neutral prime condition, 1 = positive prime condition, and 2 = negative prime condition). The Dependent variables self-perception of age and grip strength were treated as continuous. Following the steps outlined by previous research (Black et al., 2013; Preacher et al., 2008) the IV Prime condition was treated as the Y outcome variable, and grip strength as the X outcome variable. Self-perceptions of age were treated as the mediator in the model. Model 4 was selected.

Results (see Figure 4.4) supported the final hypothesis that self-perceptions of age would mediate the effects of the age-stereotype word primes on grip strength levels. The Figure 4.4 below shows the A, B and C paths. Path C shows that age-stereotyped prime condition was a significant negative predictor of grip strength levels (c path: b = -

2.79, $t(79) = -2.81$, $p = 0.000$). As the age-stereotype prime condition value decreased (i.e., became more negative), grip strength levels also decreased. The A path shows that prime condition was also a significant negative predictor of self-perceptions of age (a path: $b = -2.34$, $t(79) = -2.44$, $p = 0.027$). As prime condition labels increased, self-perceptions of age decreased. The B path shows that self-perceptions of age also significantly predicted grip strength levels (b path: $b = -2.76$, $t(79) = -2.82$, $p = 0.001$). Consistent with a mediation effect, the age-stereotyped prime condition no longer significantly predicted grip strength levels after controlling for self-perceptions of age ($b = .42$, $t(79) = 1.087$, $p = 0.24$). The Sobel test of the mediation effect was significant ($z = -5.86$, $p = 0.000$). In addition, the 95% confidence intervals from bootstrap analysis of the indirect effect (1000 iterations) did not include zero ($ab = -1.59$, 95% CI [-2.13, -1.16]) indicating that the indirect effect reached significance and a full mediation was found in the model.

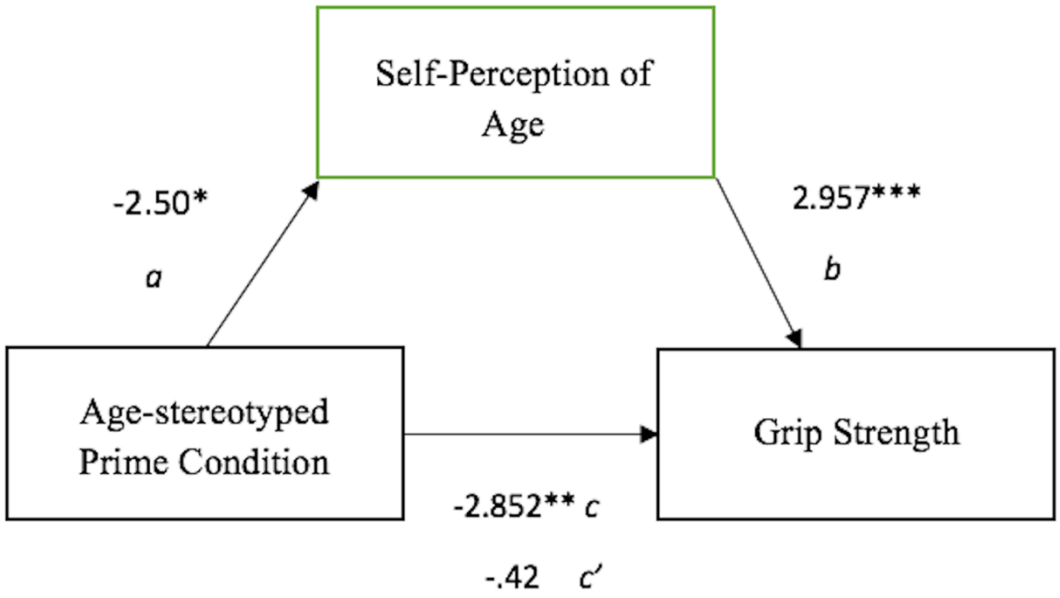


Figure 4.4

Mediation model demonstrating paths and indirect effect of self-perceptions in the age-

stereotyped prime condition – grip strength relationship

Path c = $F(1, 79) = 8.58, p < .01, R^2 = .19$

Path a = $F(1, 79) = 4.423, p < .01, R^2 = 0.15$

Age-stereotyped prime condition and self-perceptions of age together predict grip strength ($F(2,79) = 4.863$, $p < .01$, $R^2 = 0.21$)

5.6 Discussion

The key aim of study 3 was to investigate whether the natural association between self-perceptions of age and grip strength found in study 1, could be manipulated by subliminal exposure to culturally valid age-stereotyped word primes. The current study furthered previous research from a theoretical perspective by: (a) investigating whether implicit age-stereotype word primes would influence older adults' self-perceptions of age; (b) Investigating whether implicit age-stereotypes also influence older adults' health more broadly as informed by grip strength, a reliable marker of ageing (Davis, Ross, Preston, Nevitt & Wasnich, 2015); (c) As self-perceptions of age have been suggested as a potential mechanism by which positive age-stereotyped word primes increase physical functioning (Levy et al., 2014), I also investigated whether self-perceptions of age mediate the effects of age-stereotyped word primes on older adults' grip strength.

In order to achieve these aims, I used a new, bespoke age-stereotype priming task which that was developed in the previous chapter (Study 2) which addresses three methodological gaps in previous research: (a) the new and improved implicit priming paradigm addressed concerns regarding high variability in visual processing declines with age, by including a larger range of presentation durations for the implicit age-stereotyped word primes; (b) it included a neutral prime word condition to ensure that it was specifically the valence of the age-stereotyped prime words that was responsible for any changes in performance; (c) did so using culturally valid UK prime words.

5.6.1 Consistency with study 1

The pattern of descriptive statistics in the current study is different to that found in study 1. For instance, in study 1, older participants showed a trend to display significantly higher self-perceptions of age scores and grip strength levels. In the current study however, a different trend was found. Older adults in the current study had lower grip strength levels (although this difference did not reach statistical significance) and only slightly higher self-perceptions of age scores (which also did not read statistical significance). It is likely that the older adults in both studies 1 & 2 show a trend to report more positive self-perceptions of ageing in comparison to younger adults because both studies have used self-selected samples of older adults who were willing to participate in the sample on a voluntary basis. Self-selected participants themselves are relatively healthier and more functional across all ages (Golomb et al, 2012). This is however, even more pronounced in samples of older adults, where health problems and functional limitations can lead many older adults to exclude themselves from participating in research projects (Golomb et al, 2012). This does mean that self-selected / volunteer samples of older adults often report an increased health status (Golomb et al, 2012). With this is in mind, it makes logical sense that the older adults in both studies 1 and 2 report higher positive self-perceptions of their aging experience, as they are also likely to be more vigorous and have experienced less physical health problems.

In the current study, the older adults' also show trend to report lower grip strength levels than the younger adults and this is reflective of my efforts to recruit older adults from a much wider range of activities than that which were included in study 1. For instance, in the current study, participants were selected from a wider range of both physical activity classes as well as other less physically demanding activity groups, such as reading groups, genealogy groups and the University of the Third Age academic

talks. Whilst grip strength in the current study is lower for the older adults in comparison to the younger adults, this difference is marginal, indicating that the older adults grip strength levels are not low overall. Drawing upon my points above regarding self-selected samples of older adults reporting better physical health, given that the older adult sample was self-selected, it also makes logical sense that the current sample of older adults show only marginally lower grip strength than younger adults as these older adults are representative of 'healthy' older adults, who lead full and active lives.

A second possible reason why the grip strength levels in the older adults was only marginally lower than that of the younger adults in the current study is that the older adults may have exerted themselves in terms of performance on the grasping task in response to perceived pressure caused by knowing that their grip strength was to be tested. For instance, the content of age-stereotypes perpetuate that declines in older age inevitably include becoming 'weak' and 'frail' along with other declines in physical health. It is possible therefore, that in an effort to 'push back' on these age-stereotypes, the older adults may have exerted an enhanced effort during the grasping task, artificially inflating their baseline measure of grip strength.

As my key experimental assumptions within this study were supported using a sample of self-selected and healthy older adults, this suggests that it is possible that the current findings may actually underestimate the effect of age-stereotype primes on older adult's self-perceptions of age and functional health within the general public, as some of those are not health older adults.

5.6.2 Evidence that age-stereotype word primes influence self-perceptions of age and grip strength

Our experimental hypotheses were otherwise supported. In support of hypothesis 1 the younger adults' self-perceptions of age and grip strength were not affected by the age-stereotyped word primes. This is consistent from a theoretical aspect

with Levy's (2009) stereotype embodiment theory, which argues that in order for age-stereotypes to affect performance in either a negative or positive way, these must first be personally relevant to the individual. The finding that the younger adults were largely unaffected by the age-stereotype prime words therefore makes logical sense and supports the theory, as the age-stereotyped word primes in the current study incorporated ageing words which are used to characterise old age in the UK.

In support of hypothesis 2, results show that within the older sample, exposure to implicit negative age-stereotyped word primes significantly reduced self-perceptions of age, in comparison to baseline measures. Conversely, exposure to implicit positive age-related word primes significantly increased ratings of self-perceptions of age. Finally, also as predicted, exposure to neutral word primes elicited no significant changes in self-perceptions of age.

These findings are consistent with previous research that has demonstrated older adults' subjective age and self-perceptions of age are susceptible to explicit age-stereotype priming methods. For instance, Eibach et al., (2010) demonstrated that older adults who were exposed to crossword puzzles that contained negative age-stereotypes, reported significantly older subjective ages (e.g., felt older than their chronological age) and also expressed more age-stereotypical views on traditional moral topics, such as same sex marriage. In contrast, those older adults that received positive age-stereotype crossword puzzles reported feeling younger, in comparison to baseline measures. Further research (Khotter-Gruhn et al., 2012) has also demonstrated that older adults' self-perceptions of age and subjective age are both susceptible to the influence of age-stereotype photo priming tasks. For instance, the activation of negative age-stereotypes had negative effects on several indicators of self-perceptions of aging. First, older adults in good health reported decreased self-perceptions of age (e.g., were less satisfied with their ageing experience) and also reported feeling older after being exposed to negative

stereotypes. This pattern of results was further pronounced in older adults who were considered to have a 'poorer' health status, indicating that they may be more likely to relate the negative age-stereotypes.

In support of hypothesis 3, it was found that within the older sample, exposure to negative age-stereotyped word primes significantly reduced grip strength, in comparison to baseline measures. Conversely, exposure to positive age-related word primes significantly increased grip strength, with exposure to neutral word primes eliciting no significant change in grip strength measures.

These findings are consistent with previous research examining the effects of age-stereotyped word primes on basic measures of motor control. Previous research has demonstrated detriments and improvements caused by negative and positive age-stereotyped word primes (respectively) on basic motor tasks such as balance (Hausdorf et al., 1999), and time taken to rise from a seated position (Levy et al., 2014). Furthermore, the current finding that self-perceptions of age mediate the effects of age-stereotyped word primes on grip strength is not only consistent with previous research (Levy et al., 2014), but also adds credibility to the argument that self-perceptions of age are the mechanism by which age-stereotyped primes affect performance more generally. The current work expands previous literature by demonstrating that age-stereotyped word primes can also influence a key biomarker of health and ageing, i.e., grip strength.

Post hoc analysis revealed a large effect size of age-stereotype word prime on both self-perceptions of age and grip strength. In regard to grip strength, however, results showed that the decrease in grip strength following the negative age-stereotype word prime was larger than the increase following the positive age-stereotype prime condition. These findings are consistent with a previous meta-analysis (Meisner, 2011) which reported that across 7 age-stereotype priming studies, negative age-stereotype primes elicited a larger effect on behaviour outcomes in older adults. The current work

is the first study to consider the effects of age-stereotype word primes using UK generated positive and negative age-stereotype word primes and testing within a UK based sample of older adults. Meisner noted that of the 7 studies included in his meta-analysis, 6 of those reported US based samples, and the remaining study incorporated a Canadian sample of older adults; highlighting that little is known regarding how negative or positive age-stereotypes influence functional health across nations. The current findings therefore further our understanding of how age-stereotypes operate across nations; demonstrating that the effects of positive and negative age-stereotype priming conditions are consistent across these western nations, despite any potential small variations in popular ageing stereotype content.

In support of hypothesis 4, and for the first time, the current study demonstrated that, in older age, self-perceptions of age mediate the effects of age-stereotyped word primes on grip strength. These results support the argument that age-stereotypes can affect older adults' physical functioning by acting as an intervention which either strengthens or weakens older adults' self-perceptions of their own ageing (according to positive or negative age-stereotype prime content, respectively), which in turn acts as an intervention to strengthen or weaken physical function (Levy et al., 2014). One upshot of this finding is that it may suggest those older adults who report more positive self-perceptions of age are less vulnerable to the adverse effects of popular negative age-stereotype primes. Unfortunately, by the same token, these results may also mean that those older adults who report negative self-perceptions of age may be more susceptible to the adverse effects of negative age-stereotypes.

5.6.3 Implications of the current findings

These findings contribute to the growing body of research on the implications of age-stereotypes on the ageing process. Indeed, this study reveals that the grip strength of an individual may be characterised by the psycho-social factor of age-stereotypes.

Given that lower levels of grip strength are known to predict accelerated decline in psychological, physical and cognitive functional health in older age (Taekema, Gussekloo, Maier, Westendorp, & de Craen, 2010), our findings that negative age-stereotypes significantly reduced grip strength, and positive age-stereotypes significantly increased grip strength in older adults hold wide implications for theories on health and cognition in ageing. For instance, it is currently not clear why lower levels of grip strength predict psychological, physical and cognitive functional health in older age. The current work highlights that two potential mediating factors in the relationship may be positive age-stereotypes or positive self-perceptions of age. Previous research has demonstrated that negative age-stereotypes act as barriers limiting older adults' participation in regular exercise programmes (Horton, Baker, & Deakin, 2007), which in turn could accelerate decline in muscle strength. Furthermore, research investigating long-term ageing beliefs demonstrates that over a twenty-year period, older adults who hold poor self-perceptions of age are less likely to engage in preventative health behaviours, such as participating in regular exercise, maintaining a healthy diet, complying with medication schedules, and attending regular GP visits (Levy et al., 2004), also possibly accelerating decline in muscle strength.

The present findings also have direct implications for clinical ageing interventions. The degree to which an older adult endorses negative age-stereotypes could be used as an early marker of an individuals' risk of functional decline in grip strength with older age, may inform about the individual's risk of frailty and mobility limitations. Furthermore, the finding that positive age-stereotyped prime words increased grip strength more than the negative age-stereotype prime words reduced grip strength, highlights the potential that relatively simple interventions could have. For example, interventions that promote positive self-perceptions of age, such as the Generations Working Together programmes (McKay, *Olds Cool Intergenerational*

Project, 2018) which aim amongst other things to breakdown age-stereotypes between these groups, could improve self-perceptions of age, and in turn act as an intervention to help maintain grip strength and propensity to engage in and maintain physical fitness in older age. The subjective age literature (e.g., Stephan, Kotter-Grühn, & Jaconelli, 2013; Stephan & Terracciano, 2015) supports the assertation that how old or young an individual feels is an important marker of development, with a growing interest directed at the potential benefits of a youthful subjective age for wellbeing and health-related outcomes in older age.

Moreover, recent research demonstrates that manipulations to older adult's subjective age, so that they felt younger, resulted in increased grip strength (Stephan et al., 2013). As reduced levels of grip strength predict nursing home admissions (Rantanen et al., 2010), and the social care crisis that the UK currently faces regarding social care costs, positive age-stereotype interventions could be beneficial in keeping older adults living healthily and functioning independently at home for longer. Further implications of the current findings will be discussed in the General Discussion.

5.6.4 Conclusions

Two messages emerge from this research. Positive age-stereotype priming improves older adults' positive self-perceptions of age, and subsequently acts as an intervention to increase grip strength. Negative age-stereotypes increase older adults' negative self-perceptions of age, which in turn reduces grip strength during the same grasping task. The finding that positive age-stereotyped word primes improve grip strength (albeit less than negative age-stereotype word primes decreased grip strength), does still highlight the possible benefits of relatively simple, positive age-stereotype priming interventions to improve functional health in old age, as measured by grip strength. The study's final finding that self-perceptions of age mediate the effects of age-stereotype word primes upon older adults' grip strength ultimately suggests that

older adults who hold more positive self-perceptions of age may be more resistant to the adverse effects of negative age-stereotypes, in comparison to those who hold poorer self-perceptions of age. The concept of positive self-perceptions of age acting as a protective 'barrier' against the effects of negative age-stereotype prime words will be explored further in the following chapter (Study 4).

Chapter 6: Study 4: Individual differences in susceptibility to age-stereotype priming effects: Are older adults with lower self-perceptions of age more vulnerable to the effects of age stereotyped word primes, in terms of (a) the amount of change in grip force from baseline to post-priming and (b) the extent to which these effects are also cumulative across trials.

6.1 Introduction

Study 1 of the current thesis demonstrated that older adults' self-perceptions of age successfully predicted grip strength (after controlling for age, education and gender), but this was not the case for younger adults. Study 3 (experiments 1 and 2) further demonstrated that implicit age-stereotyped word primes can successfully manipulate both older adults' self-perceptions of age, and grip strength. Interestingly, mediation analysis revealed that in fact exposure to the age-stereotype word primes increased or decreased older adults' self-perceptions of age (dependent on the valence of the age-stereotype prime) which in turn then acted as an intervention to either increase or decrease grip strength. As the effects of age stereotyped word primes are a function of self-perceptions of ageing, the current study aims to explore whether there are individual differences in the vulnerability to the priming effects. Knowledge about which individual differences contribute to stereotype sensitivity may be useful for identifying those most at risk of age-stereotype effects in real world scenarios.

Lack of accounting for individual differences in susceptibility to priming effects may be another reason (in addition to methodological limitations) why some studies fail to replicate priming effects. Failure to replicate is often cited as a main criticism of age-stereotype research. Whilst a number of published and unpublished research projects have demonstrated that age-stereotypes do affect older adults' functional health / motor control (Levy et al.,2003; Levy et al., 2014; Horton et al., 2007; Horton et al., 2010 [unpublished]), a number of papers also report null findings (Moriello et al., 2013).

While these papers report null effects of the age stereotype primes, they also performed checks on the explicit age-stereotype manipulations, which highlight that the age-stereotype priming paradigm had been successful. That is, participants had successfully processed / encoded the age-stereotype prime content below their level of consciousness.

Results across all studies demonstrated that the pattern of findings were in the predicted direction, however, they did not reach statistical significance. This suggests that the participants were in fact affected by the age-related stereotype primes, despite the failure to detect statistically significant changes in performance, resulting in them still being able to recall the content of the explicit age-related stereotype primes up to 30 mins after exposure. Ultimately, these conflicting results have led some researchers to consider whether certain individual differences may play a role in providing some older adults with a protective 'barrier', leaving these select participants less vulnerable to the effects of age-stereotypes (Hess et al., 2004; Horton et al., 2010).

6.1.1 Individual differences mediating the effects of age-stereotypes

At present, very few published studies have considered whether individual differences leave some older adults more vulnerable to the effects of age-stereotypes. The only two individual differences which have previously been considered by age-stereotype research are domain investment and education levels.

The notion of investment in the domain being evaluated is an important component of stereotype threat theory. Studies amongst different populations have found that those more invested in a particular domain are generally more susceptible to a negative stereotype. For instance, within younger adults, stereotype threat impacted more upon performance across several different domains when the stereotypes involved a valued trait or an important part of the individual's identity (e.g., Steele & Aronson

1995; Spencer et al., 1999; Leyens. Désert, Croizet, & Darcis, 2000). The findings within seniors have been more equivocal, however. Hess et al. (2003) originally suggested that older adults' investment in the domain of memory mediated the effects of age-stereotype threat upon memory performance. Whilst this was so, no subsequent research (Hess et al., 2004, Hess & Hinson, 2006) has since replicated these findings. Instead several studies have found no effect of domain investment mediating the effects of age-stereotypes upon memory performance.

In a similar vein, recent research (Horton et al., 2010) using a larger scale of participants has examined whether older adults' investment in both physical and cognitive domains mediated the effects of age-stereotypes upon both physical and cognitive performance. Using a stereotype threat paradigm, participants cognitive functioning was assessed using memory recall measures, and physical functioning was assessed using measures of: walking speed, a sit and reach test, simple and choice reaction time. Results demonstrated no relationship between older adults' investment in either the physical or cognitive domains and performance on any of the measurements of either physical or cognitive ability. Further to this, and most crucially, there was no evidence to suggest that those who were more invested in their memory performance performed worse on the recall task when under stereotype threat. Similarly, there was no evidence to support the conclusion that those who were more invested in their physical capabilities performed worse on any of the tasks measuring physical ability when confronted with the negative age-stereotypes, in comparison to those who were less personally invested in their physical performance.

Whilst the evidence to support the idea that an individual's domain investment may mediate the effects of age-stereotypes is largely inconclusive, a larger number of studies (3) report no relationship between domain investment and performance after exposure to an age-stereotype compared to those which do report a relationship (1).

There is, however, evidence that there are two other more reliable individual differences which appear to mediate the effects of age-stereotypes upon performance within older adults - an individual's level of education, and self-perceptions of one's own ageing process.

Andreoletti and Lachman (2004) investigated whether young, middle-aged and older adults' memory performance would be differently affected by exposure to age-stereotypes and whether these effects would vary by education level. Results demonstrated that whilst the age-stereotypes affected only the memory performance of older adults, the age-stereotype threat condition effects varied as a function of education. For those participants with less education, the effects of the age-stereotype threat (information regarding age differences on the memory task) resulted in lower recall performance compared to those with higher education levels. More specifically, results concluded that older adults who had completed less than 4 years of further education (the standard time taken to complete a bachelor's degree) were more at risk to experience the effects of age stereotype threat upon memory performance, compared to those older adults who had completed more than 4 years of further education. Recent research (Smith et al, 2017) has replicated similar findings, demonstrating that older adults with lower levels of education were more likely to recall false information during a memory task after exposure to negative age-stereotypes in comparison to those older adults with higher levels of education.

Emerging research has demonstrated that older adults' self-perceptions of age mediate the effects of age-stereotypes. For instance, Levy et al., (2014) investigated the longitudinal effects of positive age-stereotypes upon several measures of physical functioning (time taken to rise from a seated position, balance, gait, time taken to walk 8 feet, and the ability to stand in a semi tandem position for 10s). Overall results demonstrated that exposure to positive age-stereotypes improved both physical

performance on the above measures, and self-perceptions of age, across a 16-week period. Of particular relevance, however, using path analysis the results also demonstrated that the positive age-stereotypes acted as an intervention which strengthened older adults' self-perceptions of age which then in turn were responsible for improving older adults' performance on the physical function task.

One limitation of Levy et al (2014) is that the experimental design only considered the effects of positive age-stereotypes upon simple physical health measures. In study 3, I investigated the effects of both positive as well as negative age-stereotyped word primes on a key kinematic measure (grip strength) which is indicative of health. The findings from study 3 of the current thesis replicated consistent findings with those outlined by Levy et al (2014) but extended our understanding of the effects of age-stereotyped word primes demonstrating for the first time a consistent pattern of results within kinematic measures of grip strength during a reaching and grasping task.

Whilst both these studies show that it is changes in self-perceptions of age which are responsible for changing older adult's physical performance, no study to date has examined whether age-stereotypes effect functional health differently depending upon older adults' self-perceptions of age. For instance, are those older adults with lower self-perceptions of age more susceptible to the effects of age-stereotypes?

In the cognitive literature, a commonly cited question asks, "is age kinder to the initially more able?" It appears that the answer is both yes and no (Gow et al., 2012). Research does show that particular individual differences can render some individuals as initially more able, which offers them cognitive protection so that they experience a slower rate of decline/better cognitive functioning in later life. This pattern / trend is known as preserved differentiation. However, other cognitive literature has also shown that particular interventions can also successfully protect against decline and help increase some measures of cognitive functioning (Vaportzis, Martin & Gow, 2017).

In a similar vein, it is possible that other individual differences, such as self-perceptions of age, also exert a preserved differentiation effect on older adult's functional health. That is, those older adults who report more pore positive self-perceptions of age (higher scores) may be protected against declining performance on functional health measures when exposed to negative age-stereotyped stimuli.

Consistent with this idea, previous research (Levy, Slade & Kasl, 2002) has demonstrated similar findings; older adults with higher and lower positive self-perceptions of age did not differ at baseline measures of functional health, over an 18-year period (after the age of 50 years) those older adults with lower self-perceptions of age experienced a greater trajectory of functional health decline in comparison to those with higher positive self-perceptions of age. More recent research has since replicated similar findings, where Levy, Ferrucci, Zonderman, Slade, Troncoso and Resnick (2015) demonstrated that older adults' self-perceptions of age also altered the trajectory of health-related decline as measured by Alzheimer's disease biomarkers. Despite no differences in baseline measures of Alzheimer disease biomarkers, those older adults who reported more negative self-perceptions of age experienced a steeper decline in hippocampal volume along with significantly more composite-plaques-and-tangles scores, in comparison to those who reported more positive age-stereotype based self-perceptions of age.

Study 3 of the current thesis, however, has since highlighted that there is also an element of differential preservation effects present (where manipulating particular beliefs can alter the developmental course of age-related decline) between older adults' self-perceptions of age and functional health. For instance, in study 3, results demonstrated that older adults' self-perceptions are amenable to change, and this change in self-perceptions of age was responsible for increasing grip strength levels during a grasping task. This is positive news for interventions as while those older adults with

more positive self-perceptions of age may be initially protected from performance declines resulting from exposure to negative age-stereotypes, it also shows that positive age-stereotype interventions can lead to more positive self-perceptions of age in older adults which can subsequently increase measures of functional health.

Whilst we know that exposure to positive or negative age-stereotypes can alter self-perceptions of age which in turn alters performance measures, at present, questions remain unanswered as to whether the positive and negative age-stereotype primes effect those with lower and higher self-perceptions of age equally?

Given that those older adults with lower self-perceptions of age have been shown to experience a greater trajectory of decline in functional health (compared to those with higher positive self-perceptions of age) it is logical to assume that older adults with lower self-perceptions of age may also be more affected by negative age-stereotype priming.

Recent research examining how stereotypes and social information are processed (Wigboldus, Dijksterhuis, & Van Knippenburg, 2000) also supports this prediction, and has shown that people encode social information in a stereotype-maintaining way. Put more generally, when processing social information (such as age-stereotypes) individuals show a preference to focus encoding processes upon information which acts as evidence in favour of one's existing beliefs. With this in mind, it is logical to assume that those older adults with poorer self-perceptions of age may be more vulnerable to the adverse effects of negative age-stereotypes as they may focus their encoding processes upon the negative age-stereotype word primes that are consistent with their existing poor self-perceptions of their own ageing experience. Ultimately this may allow for a larger effect of the negative primes upon functional health for those with poorer self-perceptions of age in comparison to those who report positive self-perceptions of their own ageing experience.

While it may be argued that there are benefits for individuals to focus encoding processes upon on social information which fits with their existing beliefs, it also allows the individual to avoid obtaining counterevidence, and therefore makes stereotypical views (such as poorer self-perceptions of age) reinforced and more resistant to change (Dijksterhuis & van Knippenberg, 2000). This would suggest that it is likely that those older adults with poorer self-perceptions of age are less likely to gain the benefits associated with positive age-stereotypes (Levy, 1996; Levy et al., 2000). As the positive age-stereotype prime information is not consistent with their existing negative self-perceptions of own ageing experience, the information may not be as readily encoded, resulting in smaller improvements in functional health. For age-stereotype priming interventions, this means that it may take more time and harder work to correct negative age-stereotypes in those older adults with lower self-perceptions of age. In comparison, those who hold positive self-perceptions of age may focus information processing on encoding the positive age-stereotype information that is consistent with their existing positive beliefs about ageing.

Not only is it possible that those with poorer self-perceptions of age are more vulnerable to the negative effects of age-stereotypes, they may also be more vulnerable to cumulative effects across priming trials Hehman et al., (2013) examined the effects of age-stereotype threat upon the performance of both younger and older adults during a memory task. They found that age-stereotypes within the two age groups function distinctly differently from one another. Within the older adults, not only did exposure to negative age-stereotype threat result in a stereotype confirmation effect (e.g., negative age-stereotypes resulted in decreased performance measures), these effects occurred in an *additive* manner. This means that the more stereotype threat experienced, the poorer their performance on the cognitive task became. The reverse pattern was found for younger adults, for whom instead of succumbing to the stereotype threat, they showed a

pushback response against the threat by demonstrating increased performance on the cognitive task. This means the more stereotype threat, the better the younger adults performed.

Combining these and Dijksterhuis et al., (2000) findings above (that when processing social information such as age-stereotypes, individuals show a preference to focus encoding processes upon information which acts as evidence in favour of one's existing beliefs), it is possible that older adults with poorer self-perceptions of age will actually require exposure to fewer negative age-stereotypes (i.e., trials) to significantly reduce measures of functional health in comparison to those higher self-perceptions of age. In contrast, when exposed to positive age-stereotypes it is possible that in order to improve functional health measures those with poorer self-perceptions of age will require exposure to a greater number of positive age-stereotypes (i.e., trials) as this information is not consistent with their pre-existing beliefs so will not be as readily encoded as the negative age-stereotypes.

At present, age-stereotype priming research is limited from theoretical and methodological perspectives. From a theoretical perspective there are two limitations. 1) Previous research has only investigated individual differences in vulnerability to the effects of age-stereotypes in terms of domain investment or education level. No research has compared the effects of age-stereotypes based on individual differences in older adults' self-perceptions of age. This leaves unanswered questions as to whether those with lower self-perceptions of age are more susceptible to the adverse effects of the age-stereotype primes in comparison to those with more positive self-perceptions of age. Knowledge about whether an older adult's self-perceptions of age can contribute to age-stereotype priming sensitivity would not only be useful for identifying those whom are most at risk of experiencing adverse effects resulting from age-stereotyping but would also be useful for predicting and preventing age-stereotype effects in real world

scenarios. 2) The previous age-stereotype priming literature which has divided older adults based on individual differences (e.g., low vs high levels of domain investment) and compared the effects of age-stereotypes upon performance, has focussed largely upon cognitive measure such as memory recall, or basic measures of physical health (such as the time taken to rise from a seated position). Other markers of health should be considered, such as grip strength. As this thesis has previously discussed, grip strength is considered to be a reliable marker of physical health in old age, predicting nursing home admission (Rantanen, Volpato, Ferrucci, Heikkinen, Fried, & Guralnik, 2003) and more recently, mortality (Volaklis, Halle, & Meisinger. 2015).

Regarding methodological limitations, previous research that has considered how age-stereotypes function within older adults is also limited in three ways. 1) Previous research examining the role of individual differences have all adopted explicit age-stereotype threat priming paradigms. To date, no research has examined the role of individual differences when using implicit age-stereotype priming paradigms. This is important because much like racism and sexism, biased judgements of others based on age, can operate both within and outside of an individual's conscious awareness. For instance, Chopik and Giasson (2017) have shown that an older adult can overtly express positive judgements of other older adults (e.g., using positive language to describe old age) but still hold implicit negative and ageist judgements of other older adults (e.g., where an individual is biased / ageist without realising it). This means that in terms of how age-stereotypes function, in real world scenarios exposure to many age-stereotypes may be very subtle, and often go unnoticed by older adults on a day-to-day basis (Perdue & Gurtman, 1990). 2) Research considering whether the effects of age-stereotypes influence older adults functioning in a cumulative manner have also focussed upon using stereotype threat paradigms (Hehman et al. 2013). It is still unclear as to whether implicitly presented age-stereotype prime words demonstrate a cumulative

effect upon older adults' functional health, much like stereotype threat appears to (Hehman et al. 2013). 3) Finally, previous research has also not addressed whether particular subgroups of older adults (individual differences) are more vulnerable than others to cumulative effects of age-stereotype priming.

In the present study, I aimed to advance previous research from a theoretical perspective by examining whether the effects of age-stereotypes upon older adults' functional health, as measured by grip strength (a key biomarker of successful aging), would be differently affected based on older adults' levels of self-perceptions of age.

From a methodological perspective, in the current study I also aimed to advance previous research by: 1) using an implicit age-stereotype word priming paradigm to present the positive, negative and neutral implicit age-stereotype word primes; 2) To determine whether one group (i.e., those with lower, or those with higher, self-perceptions of age) is also more vulnerable to repeated effects of the age-stereotype word primes over time (trials).

6.1.2 The current study

Based on previous research above (Dijksterhuis et al., 2000) that demonstrates when processing social information (such as age-stereotypes) individuals show a preference to focus encoding processes upon information which acts as evidence in favour of one's existing beliefs and that negative age-stereotypes appear to operate in a cumulative manner (Hehman et al., 2013), I advanced the following hypotheses. (1) Exposure to negative implicit age-stereotyped word primes would decrease grip strength more for those with lower ratings of self-perceptions of age than those with higher ratings of self-perceptions of age. (2) Exposure to positive implicit age-stereotyped word primes would increase grip strength less for those with lower ratings of self-perceptions of age in comparison to those with higher self-perceptions of age. (3) Exposure to neutral prime words would not affect grip strength levels for either older

adults with lower or higher self-perceptions of age. (4) Older adults with lower self-perceptions of age will require exposure to fewer negative age-stereotypes (i.e., trials) to significantly reduce grip strength in comparison to those with higher self-perceptions of age. (5) Those with lower self-perceptions of age will require exposure to a higher number of positive age-stereotype word primes (i.e., trials) in order to increase grip strength.

6.2 Method

6.2.1 Design

Previously in study 3 a block design was used where changes in grip strength were measured prior to and post exposure to a block of 20 age-stereotyped prime words. This design was changed in the current study in order to accommodate examining changes in grip strength over cumulative trials. As I was also investigating changes in grip strength following priming across trials (i.e., cumulatively), in the current study the DV of grip strength was measured by calculating the change in grip strength from baseline to post priming after each trial. Please see the procedure section for a full outline of these changes.

6.2.2 Participants

As the current study incorporated a new design to test for cumulative effects, a new sample of participants were recruited. G*Power (Faul, Erdfelder, Buchner, & Lang, 2009) was used once again to calculate the required sample size.

A previous meta-analysis by Lamont, Swift and Abrams (2015) considering the effects of age-stereotypes on physical activity, suggests that the average effect size of age-stereotype primes on physical functioning tasks is an effect size of around 0.32.

A power analysis using G*Power (Faul, Erdfelder, Buchner, & Lang, 2009) was performed to calculate the sample size needed when performing a Mixed ANOVA in order to detect significant main effects and interactions between the (BS) variables self-perceptions of age group) and the (WS) variable (time of measurement).

When using G*Power, the F-test family was chosen, and the 'ANOVA Repeated measures, between factors test' (mixed ANOVA) was chosen. A previous meta-analysis by Lamont, Swift and Abrams (2015) considering the effects of age-stereotypes on physical activity, suggests that the average effect size of age-stereotype primes on physical functioning tasks is an effect size of around 0.32. I therefore calculated my sample size based on a medium effect size of 0.32. Probability was set a 0.05 and power level was selected at the recommended 0.8 level (Cohen, 1998). The number of groups was inputted as 2 (lower and higher self-perceptions of age groups), and the number of measures was inputted as 5 (grip strength was measured at baseline and after 5, 10, 15, & 20 primes). G*power informed that a sample size of 48 participants would be required.

With this in mind, a sample of 48 older adults (60-91 years, M = 71.86, SD = 5.78, 75% female) were recruited from an older person's information day in Edinburgh, where I manned an information stall handing out fliers offering the opportunity to participate in the study. The information day offered information regarding many different activities/opportunities (book reading, bingo, yoga, carpet bowls, allotment groups and the University of the Third Age) for older people who are 50+ years. This allowed me to access participants across a wide range of classes (i.e. who have a wider range of ability within this healthy group). As it was myself who handed out the fliers, it allowed me to ensure all participants met the inclusion criteria before attending any lab-based testing sessions. This was beneficial as the university campus can be problematic to reach via public transport, and so screening before participating in the study ensured I did not waste any of my participant's valuable time. This method meant that no participant was excluded from participating in the study. For full exclusion criteria, please see the screening subsection below. Written informed consent was given by all participants prior to participation, and all experimental procedures were approved by the

Ethics Committee at Heriot-Watt University.

6.2.3 Materials and Equipment

Screening. Consistent with the previous studies in this thesis, in addition to the Mini Mental State Exam (MMSE, Folstein & McHugh, 1975), participants completed a health questionnaire. Participants who (1) scored less than 27/30 on the MMSE, (2) reported a neurodegenerative, eyesight or movement disorder, or (3) were taking medications that may cause tremors during a grasping action were excluded from the study.

Independent variable: Self-perceptions of age. Consistent with the previous studies in the current thesis and also with previous research (Liang & Bollen 1983; Levy et al., 2004), participants' self-perceptions of their own ageing experience were measured using the five-item subscale of the Philadelphia Geriatric Centre Morale Scale (Lawton, 1975). Items were rated on a 5-point scale (ranging from 1- strongly disagree to 5- strongly agree (higher scores indicate greater satisfaction with their own ageing experience). The subscale consists of items such as: "As I get older, things are (better, worse or the same) as I thought they would be."

Outcome variable: Grip strength. Grip strength was also measured using the same materials as those detailed in studies 1 & 3, i.e., in newtons (500 Hz) using a single 6-axis force sensor (Nano 17 transducer, ATI industrial automation, NC). Each object that participants lifted had a plastic mount on the centre of its top surface, containing the force sensor. Participants used this handle to grip and lift the object with their thumb and index finger on a pair of textured finger pads with a diameter of 25mm. During practice trials, participants were asked to grasp a small cube, and during test trials a small cylinder was used. Both objects were made from black plastic, and tailored to a height of 7.5 cm, and weight of 200g.

As the current study is examining the amount of change in grip strength across

trials, I measured grip strength by subtracting grip strength pre-priming from grip strength post- priming (i.e., a baseline adjustment), to control for individual variation in baseline levels of grip strength. More specifically, to create baseline adjusted grip strength scores, each participant's baseline measure of peak grip strength was subtracted from their peak grip strength during each grasping trial. Larger baseline adjusted grip strength scores represent a larger change from the baseline measurement of grip strength. For instance, an adjusted grip strength score of +0.5 would indicate an increase in grip strength from baseline of 0.5 newtons. An adjusted grip strength score of -0.5 would indicate a decrease in grip strength from baseline of 0.5 newtons. This baseline adjustment procedure was repeated for each grasping trial and was averaged across all participants within each age-stereotype prime condition.

Implicit age-stereotyping priming paradigm. Participants were subliminally exposed to the positive, negative or neutral age-stereotyped prime words on a computer screen, using my improved priming paradigm (created using PsychoPy V1.8) that was detailed in Chapter 4 (study 2). To address criticisms that previous priming paradigms did not account for the high variability in older adults' visual processing speeds (Wiegand et al., 2014), and thus to ensure that the priming stimuli were encoded below each participant's level of conscious awareness, I developed a two-step priming task.

Step 1 identified the optimal presentation duration for the age-stereotyped word primes, based on individual visual processing speeds. Step 2 of the procedure was the priming intervention; each participant's optimal presentation speed from step 1 was used to present the age-stereotyped word primes during the priming intervention (for a full description of priming paradigm please see study 2 phase 2.

Whilst the priming paradigm remained unaltered from the previous study 3, the priming procedure was altered in current study to accommodate cumulative analyses. Rather than presenting the participants with all 20 age-stereotyped word primes

consecutively and measuring grip strength after completing all 20 age-stereotyped word primes as per study 3 (i.e., grip strength performance was measured after a block of age stereotyped prime trials), participants' grip strength performance was instead measured after each age-stereotyped word prime trial, for 20 trials. This new procedure allowed me perform analyses based on the average grip strength across all trials in each age-stereotype prime condition, but it also allowed me to compare grip strength within trial number (i.e., after 5, 10, 15 or 20 age-stereotyped word primes) and also across participants (e.g., between those older adults with higher and lower self-perceptions of age).

Covariates. Consistent with previous research (Andreoletti et al. 2004) reviewed in the current study, I included years of education as a covariate. Education level was measured using a questionnaire which asked participants to indicate the number of years of education they had completed after secondary.

6.2.4 Procedure

Phase 1 - Screening. On arrival to the lab, just like in study 3, participants were reminded that they were participating in a study which measured their individual visual processing speed, and their ability to focus their attention resources on a computer based priming task.

To ensure that the MMSE, health questionnaire and measures of participant's perceptions of own ageing were not acting as age primes themselves, participants were asked to complete the measures either before or after the implicit stereotype prime intervention in a counterbalanced order.

Phase 2 - Practice trials (without primes). All participants were asked to complete 5 practice trials of the grasping task to ensure that participants understood the instructions. Participants were asked to lift the cube "*straight upwards, with your thumb and index finger on the handle, in a smooth and confident fashion, around 5cm off the*

table, and aim to hold it steady without exerting unnecessary effort." An initial auditory sound indicated to participants to begin the grasping task by lifting the cube from the lift-off pad, and after having held the object for 6 seconds, a second auditory sound signalled to participants to lower the object back down.

Phase 3 - Baseline grip strength trials. To gain a baseline measure of each participant's grip strength, they completed 5 trials of grasping the small cylinder, with a 30-second recovery period between each trial.

Phase 4 - Selecting prime presentation speed using step 1 of the priming method. Participants then completed step 1 of the priming paradigm (for details see the implicit age stereotyping priming paradigm section of the method), which determined the optimal duration of word prime stimuli for each individual in order for word primes to be encoded, but below conscious awareness.

Phase 5 - Implicit age-stereotyped word priming intervention. Participants then completed step 2 of the implicit age-stereotype priming intervention in which they completed all age-stereotype word prime conditions. Participants were reminded that they may perceive a very quick flash appearing on the PC screen. Each age-stereotyped word prime appeared on the PC screen above or below a bulls-eye, and participants were then asked to respond by either pressing an arrow up or down key on the keyboard to indicate whether they perceived a flash above or below the bulls-eye. Participants were reminded to focus on the experiment and to respond as swiftly but accurately as they could.

Unlike the previous studies (3a and 3b) in which age-stereotype prime words were presented using in block trial method (e.g., grip was measured before and after a block of either 20 positive, negative or neutral age-stereotype prime words), participants in the current study were presented with one age-stereotype word prime at a time, which was immediately followed by instructions to complete the same grasping task as that performed in the baseline trials. This procedure was repeated across all age-stereotype

prime conditions (positive, negative and neutral) until all 20 age-stereotype word primes had been presented and 20 measures of grip strength had been recorded.

Following the end of the testing session, participants were asked what they had seen on the screen. Responses indicated that they were unaware of the implicit-intervention content, which suggests that there was not an increase in awareness during the implicit prime intervention.

Phase 6 – Debriefing. After testing was completed, participants were debriefed regarding the full aims of the study.

6.3 Results

6.3.1 Data Pre-Processing

When pre-processing and analysing the grip strength data, I followed the same data pre-processing procedure that was used in Studies 1 and 3. Please see Chapter 4 for a full description. Full Matlab code for the data pre-processing can be found at https://sites.google.com/site/obintlab/wiki/data-processing. Statistical analyses were performed in SPSS version 22.

6.3.2 Plan of analyses

Study 4 aimed to investigate whether older adults who report lower self-perceptions of age were: (a) more vulnerable to age-stereotype priming effects than those with higher self-perceptions of age; (b) more vulnerable to cumulative priming effects across trials.

I hypothesised that: (1) Exposure to negative implicit age-stereotyped word primes would decrease grip strength more for those with lower ratings of self-perceptions of age than those with higher ratings of self-perceptions of age; (2) Exposure to positive implicit age-stereotyped word primes would improve grip strength less for those with lower ratings of self-perceptions of age, in comparison to those with higher self-perceptions of age (and vice versa); (3) Exposure to neutral prime words

would not change grip strength levels for either older adults with lower or higher self-perceptions of age; (4) Older adults with lower self-perceptions of age will require exposure to fewer negative age-stereotypes to significantly reduce grip strength in comparison to those higher self-perceptions of age (5) Those with lower self-perceptions of age will require exposure to a higher number of positive age-stereotype word primes in order to increase grip strength.

A 2 (Group: lower and higher self-perceptions of age) x 3 (Prime Condition: positive, negative and neutral) x 4 (Trial Number: 5 trials, 10 trials, 15 trials and 20 trials) mixed design ANCOVA was performed to analyse hypotheses 1-5. These results are divided into 2 subsections.

The first subsection (Analysis A – individual difference in susceptibility to priming) addresses hypotheses 1-3. More specifically, this subsection examines whether there are individual differences in susceptibility to age-stereotyped priming between older adults with lower self-perceptions of age, compared to older adults with higher self-perceptions of age. To examine this, this section reports the 3-way ANOVA main effects for Prime Condition and Self-Perceptions of Age, along with the 2-way interaction between Prime Condition and Self-Perceptions of Age.

The second subsection (Analysis B – cumulative effects of age-stereotype priming) moves on to address hypotheses 4 – 5. This subsection examines whether the priming effects are cumulative, and more specifically, whether those older adults who report lower or higher self-perceptions of age are more or less vulnerable to these cumulative effects of age-stereotype priming across trials. To examine this, the subsection Analysis B, will report the main effect of Trial Number, the 2-way interactions between Trial Number and both Prime Condition, and Self-Perceptions of Age, along with the 3-way interaction between Self-perceptions of Age, Prime Condition, and Trial Number. All post hoc analysis in both subsections (A and B) were

performed using t-test with Bonferroni correction applied.

As outlined in the method section above, grip strength across trials was measured by subtracting grip strength pre-priming (i.e., baseline grip strength) from grip strength post priming. Larger baseline adjusted grip strength scores represent a larger change from the baseline measurement of grip strength. For instance, an adjusted grip strength score of +0.5 would indicate an increase in grip strength from baseline of 0.5 newtons. An adjusted grip strength score of -0.5 would indicate a decrease in grip strength from baseline of 0.5 newtons.

Self-perceptions of age were measured using the five-item subscale of the Philadelphia Geriatric Centre Morale Scale (Lawton, 1975). Items were rated on a 5-point scale (ranging from 1- strongly disagree to 5- strongly agree with higher scores indicate greater satisfaction with their own ageing experience and a maximum score of 25).

Years of education were measured by asking participants to report how many years of education they had completed including secondary school. Higher scores represent more years of education.

6.3.3 Analysis A - Individual differences in susceptibility to priming effects

In order to split the older adults into two experimental groups based on self-perceptions of age scores, a median split was performed. Consistent with previous research (Seelye, Doane, Clason, VanVoorst & Uroševic, 2019) participants who scored the median of 15 (or below) out of a possible 25 were categorised as the 'lower self-perceptions of age' group, whilst participants who scored 16 (and above) out of 25 were categorised as the 'higher self-perceptions of age' group. An independent samples t-test confirmed that self-perceptions of age scores for those older adults placed in the low self-perceptions of age group were significantly lower than those older adults placed in the high self-perceptions of age score. Please see Table 5.1.

Table 5.1

Results of t-test and descriptive statistics for grip strength scores and self-perceptions of age in older adults with low and high self-perceptions of age (N=48).

	Self-Perceptions of Age Group							
	Low Self-Perception of Age			High Self-Perception of Age				
	M	SD	n	M	SD	n	t	df
Self-Perceptions of Age [a]	13.75	1.674	24	18.125	1.918	24	-7.464***	23
Years of Education [b]	3.637	1.109	24	3.928	1.072	24	1.573	23

*** $p < .000$.
[a] Scored out of a total of 25. Higher scores represent more positive self-perception of own ageing experience.
[b] Scored out of a total of 6. Higher scores represent more years of education.

Descriptive statistics for those older adults with lower and higher self-perceptions of age can be found in Table 5.2.

Table 5.2

Change from baseline grip strength in older adults with low and high self-perceptions of age, Post Age-Stereotype Priming (N=48).

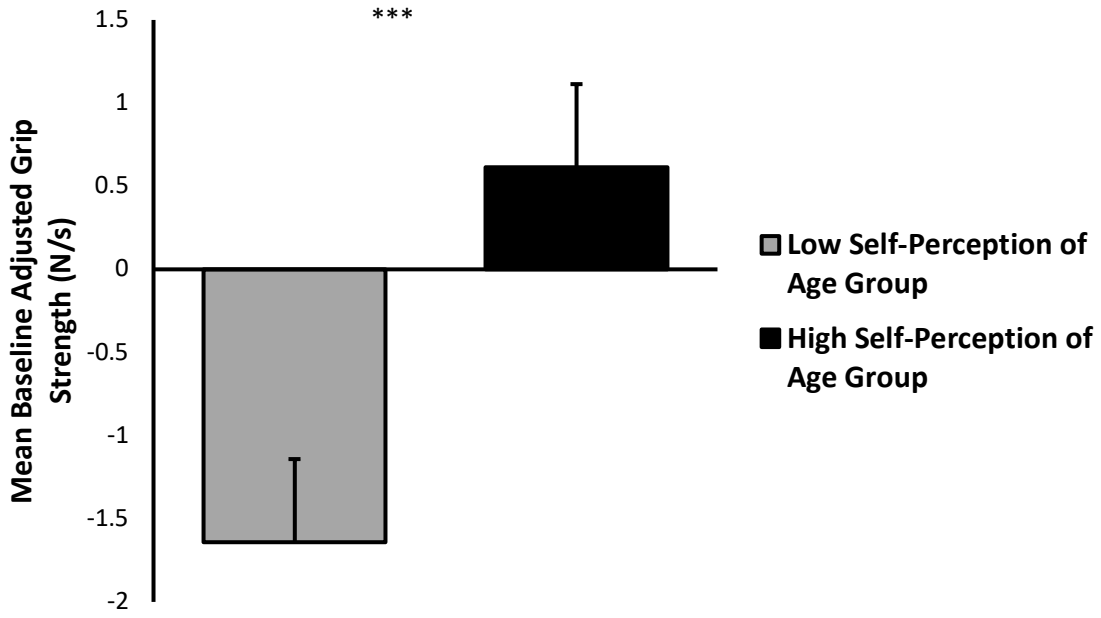
	Negative Age-Stereotype Prime Condition	Positive Age-Stereotype Prime Condition	Neutral Age-Stereotype Prime Condition
Lower Self-Perception of Age Group	-6.411 ± 1.733	2.258 ± 0.917	-0.770 ± 1.423
Higher Self Perception of Age Group	-2.303 ± 1.338	4.024 ± 0.538	-0.138 ± 1.649

Measured in newtons. Higher scores represent larger changes from baseline measures of grip strength

A mixed design analysis of covariance (ANCOVA) Group (2: lower and higher self-perceptions of age) as the between-subjects factor, and Prime Condition (3: positive, negative and neutral) as the within-subject factors was performed to investigate

the effects of prime condition on changes in grip strength from baseline measures for older adults who reported lower and higher levels of self-perceptions of age. Checks were carried out to confirm that the data met all necessary assumptions required to perform the ANCOVA, i.e., inspection of QQ plots indicated that the residuals were normally distributed and the Levene's test of homogeneity of variance indicated that the variances were similar for the between subject factor of Group (lower and higher self-perceptions of age).

The covariate comprised number of years in education and was significantly related to grip strength: $F(1,45) = 5.653$, $p = 0.01$, $\eta p^2 = 0.10$. After adjusting for this years in education covariate, results found a main effect of Self-Perceptions of age ($F(1, 45) = 12.550$, $p = 0.001$, $\eta p^2 = 0.21$); those with lower self-perceptions of age experienced a lower baseline adjusted grip strength score in comparison to those with higher self-perceptions of age ($t(47) = -3.495$, $p = 0.001$, Cohen's $d = 0.299$). See Figure 5.1.

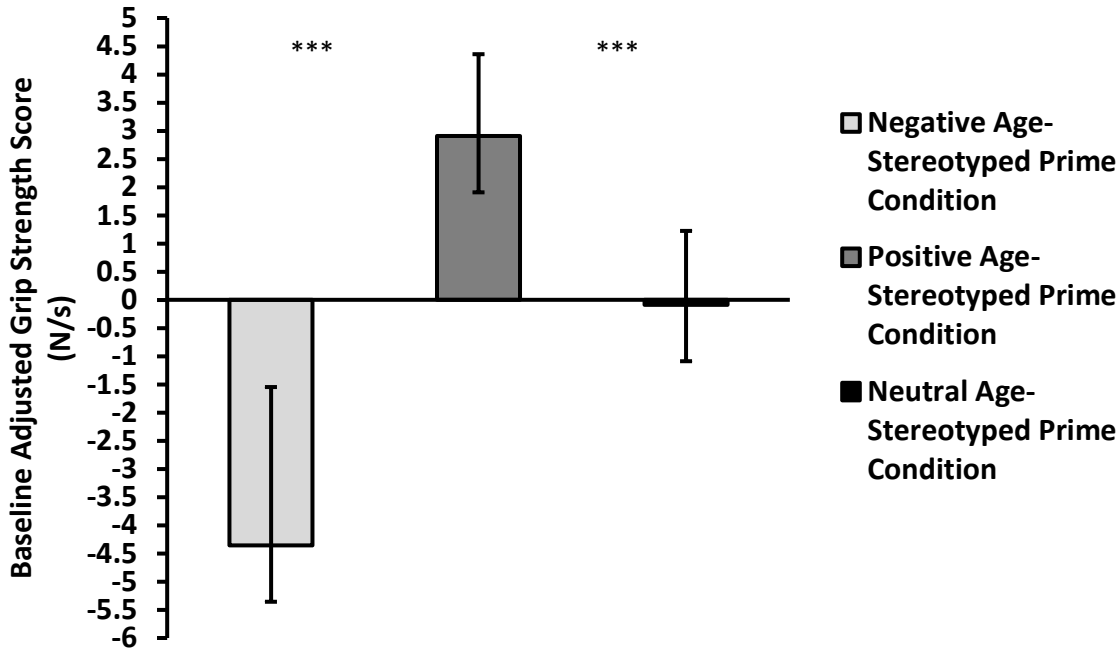


*** $p<0.001$

Figure 5.1

Mean baseline Adjusted Grip Strength Scores ± standard deviation for Older Adults with Low and High Self-Perceptions of Age (N=48).

Results also revealed a main effect of Prime Condition ($F(1, 47) = 163.751$, $p = 0.000$, $\eta p^2 = 0.78$). As expected, post hoc t-tests using Bonferroni Correction show that baseline adjusted grip strength levels were lower in the negative age-stereotype prime condition in comparison to both the positive ($t(47) = -25.042$, $p = 0.000$, Cohen's $d = -0.624$) and the neutral ($t(47) = -7.576$, $p = 0.000$, Cohen's $d = -0.701$) age-stereotype prime condition. In addition, baseline adjusted grip strength scores in the positive age-stereotype prime condition were significantly higher than in the neutral age-stereotype prime condition ($t(47) = 7.197$, $p = 0.000$, Cohen's $d = 1.40$). This pattern of results is illustrated in Figure 5.2.



*** $p<0.001$

Figure 5.2

Mean Baseline Adjusted Grip Strength Scores ± standard deviation for all Age-

Stereotype Word Prime Conditions. (N=48).

The Prime Condition by Self-Perceptions of Age group interaction was also statistically significant ($F(1, 46) = 14.702$, $p = 0.000$, $\eta p^2 = 0.24$). Post hoc t-tests using the Bonferroni correction revealed that as expected, baseline adjusted grip strength were significantly lower in the negative age-stereotype prime condition in comparison to the positive age-stereotype prime condition for older adults with lower ($t(23) = -19.098$, $p = 0.000$, Cohen's $d = -2.00$) and higher ($t(23) = -31.197$, $p = 0.000$, Cohen's $d = -2.99$) self-perceptions of age. In a similar vein, baseline adjusted grip strength levels were lower in the negative age-stereotype prime condition in comparison to the neutral age-stereotype prime condition for both those with lower ($t(23) = -7.068$, $p = 0.000$, Cohen's $d = -2.54$) and higher ($t(23) = -5.035$, $p = 0.000$, Cohen's $d = -2.30$) self-perceptions of age. Finally, baseline adjusted grip strength levels were higher in the positive age-stereotype prime condition in comparison to the neutral age-stereotype prime condition for both those with low self-perceptions of age ($t(23) = 3.273$, $p = 0.003$, Cohen's $d = 1.24$) and also for those with high self-perceptions of age ($t(23) = 11.290$, $p = 0.000$, Cohen's $d = 1.00$). See Figure 5.3.

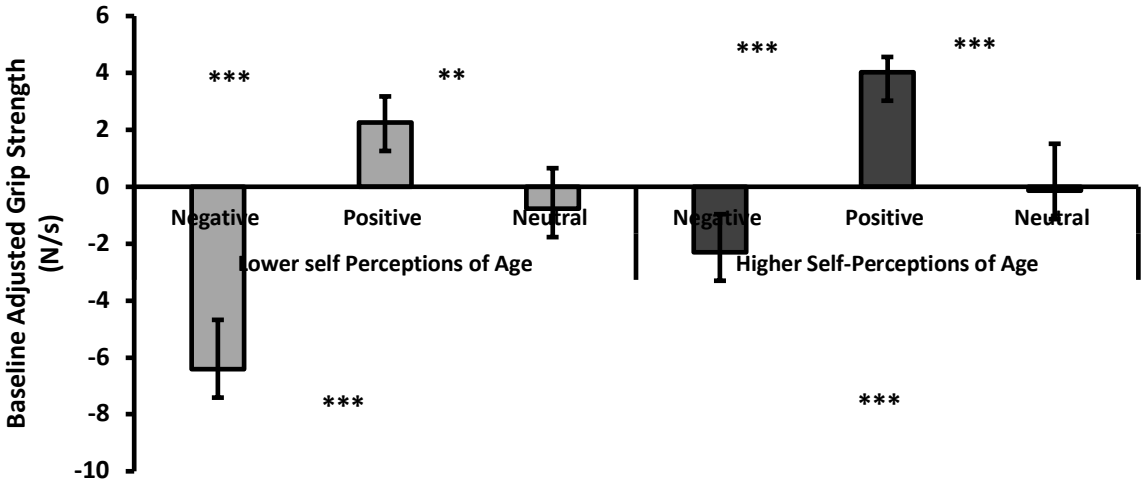


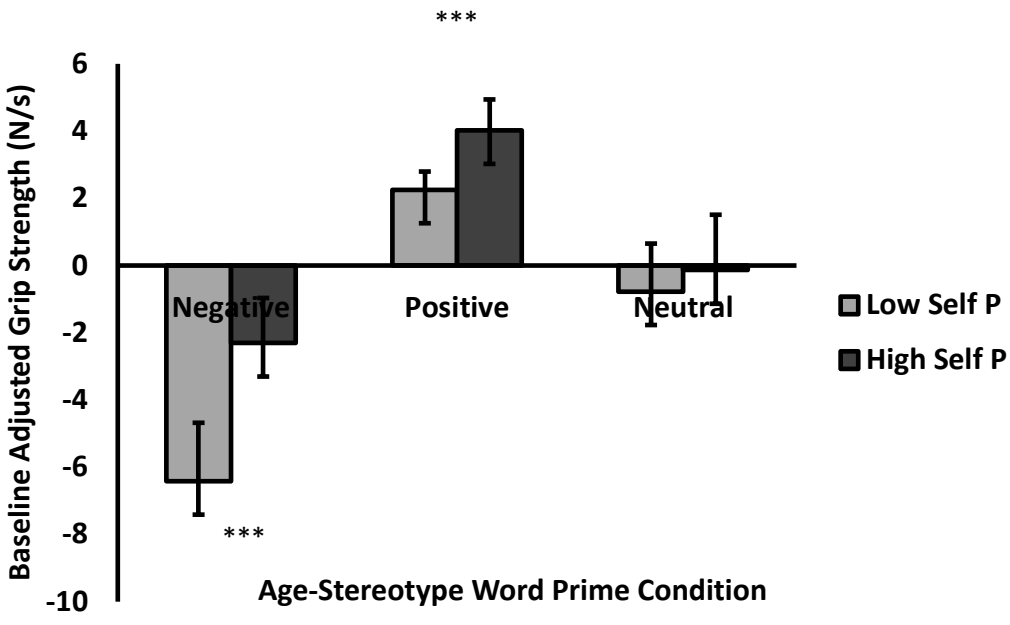
Figure 5.3

Mean Baseline adjusted Grip Strength scores ± standard deviation for Older Adults with Lower and Higher Self- Perceptions of Age Post Each Age-Stereotype Prime Intervention (N = 48).

**** p<0.001 ** p<0.01*

Further between group post hoc t-tests (Bonferroni correction applied) for the 2-way interaction revealed that in support of hypothesis 1, following the negative age-stereotyped word prime condition, older adults with lower self-perceptions of age experienced a significantly larger decrease in baseline adjusted grip strength in comparison to those with higher self-perceptions of age ($t(23) = 9.410$, $p = 0.000$, Cohen's $d = 1.66$). In support of hypothesis 2, after the positive age-stereotyped word prime condition, older adults with lower self-perceptions of age experienced a significantly smaller increase in baseline adjusted grip strength in comparison to those with higher self-perceptions of age ($t(23) = 8.417$, $p = 0.000$), Cohen's $d = 2.351$. Finally, in support of hypothesis 3, following the neutral age-stereotype word prime condition, there was no significant difference in baseline adjusted grip strength between

those with lower and higher self-perceptions of age (t(23) = 0.853, p = 0.403 Cohen's d = 0.041). Figure 5.4 illustrates this pattern of results.



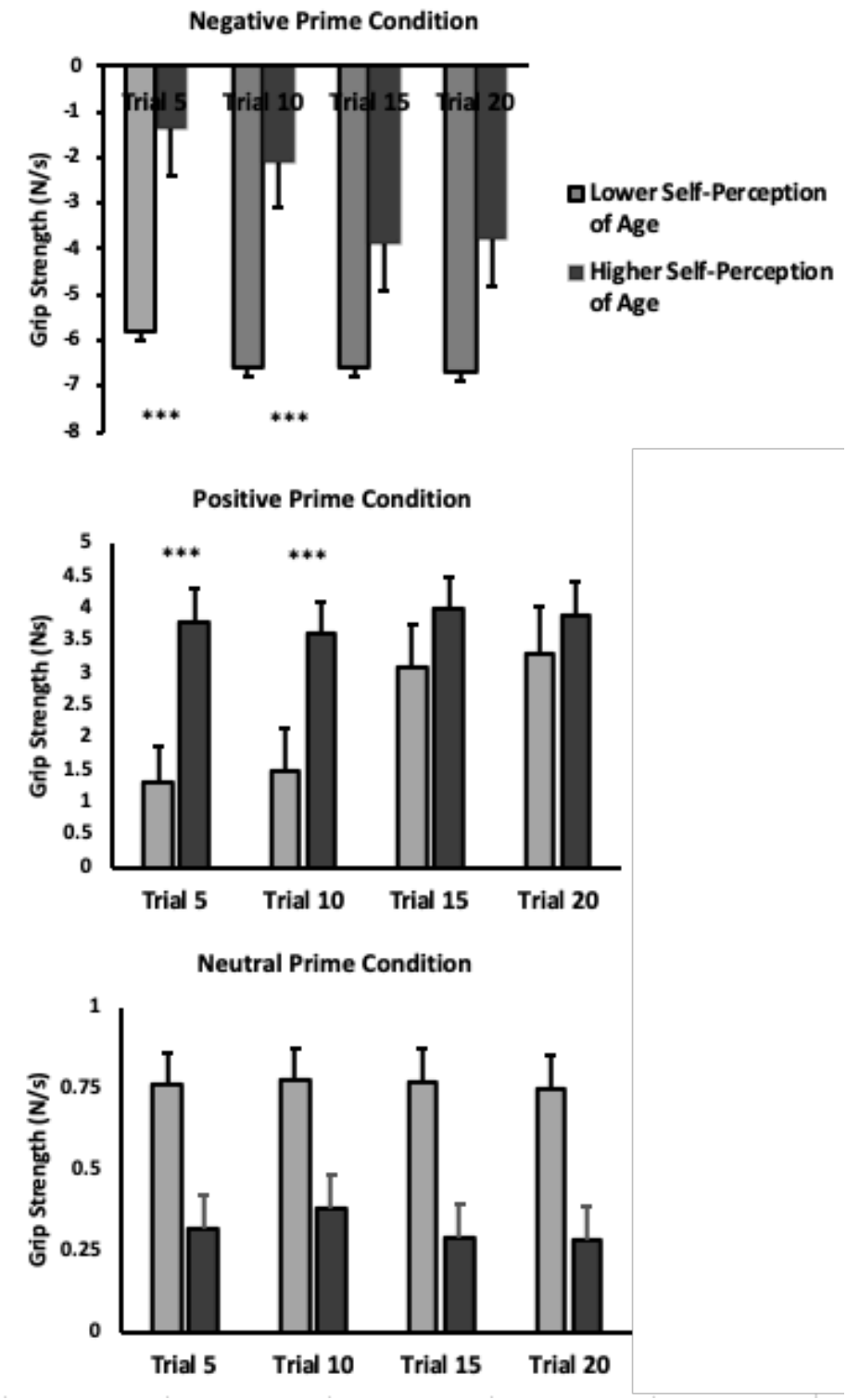
*** *p<0.001*

Figure 5.4

Mean Baseline adjusted grip strength ± standard deviation for older adults with lower and higher self-perceptions of age after each age-stereotype prime condition (N = 48).

6.3.4 Analysis B - cumulative effects of age-stereotype priming

In support of hypotheses 4 and 5 that the cumulative effect of age-stereotyped word primes would influence adjusted baseline grip strength scores differently for those with low or high self-perceptions of age, the 3-way interaction between Trial Number, Self-Perception of Age, and Prime Condition reached statistical significance (F (1,95) = 12.283, p = .001, ηp^2= 0.21). This pattern of results is presented in Figure 5.5.



***: $p < .000$

Figure 5.5

Mean Corrected Grip Strength Scores ± Standard deviation, Across Age-Stereotyped Word Prime Condition, and Trial Number for Older Adults with High and Low Self-Perceptions of Age. (N=48).

6.3.4.1 The cumulative effect of negative age-stereotype word primes

Consistent with hypothesis 4, results demonstrate that the effects of the negative age-stereotype word primes impact upon the grip strength of those with lower self-perceptions of age immediately. After 5 priming trials, there was an initial steep reduction in grip strength by 5.9 newtons, and this was statistically significant. Following on from this immediate response, for those with low self-perceptions of age, after 10 negative priming trials, it appears the effects of the negative priming words had reached floor level as the differences between baseline adjusted measures of grip strength were not significantly different from one another after 10 ($t(23) = 0.487$, $p = 0.262$), 15 ($t(23) = 0.715$, $p = 0.401$) and 20 ($t(23) = 0.815$, $p = 0.317$).

In contrast, results demonstrate a different pattern of results across trials for those older adults with higher self-perceptions of age. Results show that these participants required exposure to more negative age-stereotyped word primes in order to significantly reduce grip strength levels. For instance, after 5 priming trials, grip strength did reduce by on 0.5 newtons, but this reduction was not statistically significant ($t(23) = 0.883$, $p = 0.386$).

The negative age-stereotype word primes did, however, start to significantly reduce grip strength levels for those with higher self-perceptions of age after 10 negative priming trials. Following 10 negative priming trials, grip strength levels had significantly reduced by 1.90 newtons ($t(23) = 2.054$, $p = 0.002$) in comparison to grip strength at the 5 priming trial point. Similarly, following 15 negative priming trials, grip strength significantly reduced even further, by 3.61 newtons ($t(23) = 3.752$, $p = 0.000$).

After the 15 negative priming trials, it appears the effects of the negative priming words had reached floor level as the baseline adjusted grip strength levels following 20 negative priming trials did not significantly reduce grip strength any further (Result).

In summary, consistent with hypothesis 4, results demonstrate that the effects of the negative age-stereotype word primes impact upon the grip strength of those with lower self-perceptions of age immediately, with an initial steep decline in grip strength, which is followed by marginal decreases in baseline adjusted grip strength indicating that the effects of the negative age-stereotype prime words have reached a floor level after 10 negative priming trial onwards (as incremental decreases in baseline adjusted grip strength after 10, 15 and 20 priming trials did not reach statistical significance). In contrast, results demonstrate that for those with higher self-perceptions of age, negative age-stereotype primes did operate in a more accumulative manner, with baseline adjusted grip strength statistically decreasing more gradually until the 15 priming trial point, after which the negative primes also appeared to reach a floor affect as baseline adjusted grip strength did not significantly reduce further. This pattern of results is illustrated in Figure 5.5.

6.3.4.2 The cumulative effects of positive age-stereotype word primes

In support of hypothesis 5 (that those with lower self-perceptions of age will require exposure to a higher number of positive age-stereotype word primes in order to increase grip strength) results show that older adults with lower self-perceptions of age did in fact require exposure to a higher number of positive age-stereotyped prime words in order to increase grip strength. This pattern of results is in contrast to the pattern of results outlined above during the negative age-stereotype priming condition for older adults with lower self-perceptions of age; which shows these participants as being immediately affected by the negative age-stereotyped word primes.

During the positive age-stereotyped word priming, older adults with lower self-perceptions of age did not show an immediate improvement in baseline adjusted grip strength. For instance, results show that after 5 priming trials, whilst baseline adjusted grip strength did increase by 1.29 newtons, this increase did not reach statistical significance ($t(23) = 0.578$, $p = 0.985$).

The pattern of results show that the positive priming trials did to some extent operate in an accumulative manner, as baseline adjusted grip strength significantly increased by 1.48 newtons following 10 positive priming trials ($t(23) = 2.741$, $p = 0.001$) and also significantly increase by a further 1.57 newtons after exposure to 15 positive priming trials ($t(23) = 2.176$, $p = 0.001$).

After 20 positive priming trials, for those older adults with lower self-perceptions of ageing, the accumulative benefits of the positive age-stereotype word primes has ceased, suggesting that the effects of the positive age-stereotype primes had reached ceiling level. For instance, whilst the baseline adjusted grip strength levels do significantly increase by 3.19 newtons ($t(23) = 2.954$, $p = 0.000$) following the 20 positive priming trials, and this difference is significantly higher than the baseline adjusted grip strength after 5 ($t(23) = 3.016$, $p = 0.000$) and 10 priming trials ($t(23) = 2.824$, $p = 0.001$), this is not significantly higher than baseline adjusted grip strength levels seen after 15 positive priming trials. This suggests that the effect of the positive age-stereotyped prime words were accumulating until the 15 priming trials time point, after which the effects of the positive age-stereotype primes had reached ceiling level

The opposite pattern of results was found, however, for those older adults with higher self-perceptions of age. Results confirmed that for these individuals grip strength immediately improved following the positive priming. For instance, after 5 priming trials there was an immediate response to the positive priming words where baseline adjusted grip strength immediately significantly increased by 3.36 newtons ($t(23) = 4.284$, $p = 0.000$).

Following on from this immediate response, for those with higher self-perceptions of age, after 10 positive priming trials, it appears the effects of the positive priming words had reached floor level as there were only marginal changes in baseline adjusted grip strength levels following further priming. For instance, the differences

between baseline adjusted measures of grip strength after 10 ($t(23) = 0.725$, $p = 0.389$), 15 ($t(23) = 0.814$, $p = 0.377$) and 20 ($t(23) = 0.842$, $p = 0.399$) positive age-stereotype priming trials were not significantly different from one another.

In summary, consistent with hypothesis 5, and in contrast to the pattern of results found within the negative age-stereotype primes, results demonstrate that those with lower self-perceptions, positive age-stereotype primes did not immediately increase baseline adjusted grip strength, instead, these individuals require exposure to a higher number of positive age-stereotype word primes in order to increase grip strength. For instance, baseline adjusted grip strength did not immediately increase, and only significantly increased after 10 positive age-stereotype priming trials. This is in contrast to the immediate steep decline these participants experienced during the negative age-stereotype priming condition.

Baseline adjusted grip strength gradually increased until 15 positive priming trials, after which the positive primes appear to have reached a ceiling effect, as baseline adjusted grip strength did not significantly increase further.

For those with higher self-perceptions of age, it appears that the opposite pattern was found, in which the positive age-stereotype primes immediately significantly increased baseline adjusted grip strength by 3.36 newtons following only 5 positive age-stereotype priming trials. These improvements quickly reached ceiling levels though as after only 10 positive age-stereotype priming trials, baseline adjusted grip strength did not significantly increase further. The pattern of results is also illustrated by Figure 5.5.

6.3.4.3 The cumulative effects of neutral age-stereotype word primes

In support of hypothesis 6, the neutral priming results confirm that for those with lower self-perceptions of age baseline adjusted grip strength levels did not significantly change after 5 ($t(23) = 0.186$, $p = 0.854$), 10 ($t(23) = 0.499$, $p = 0.623$), 15 ($t(23) = 0.271$, $p = 0.789$) or 20 ($t(23) = 0.426$, $p = 0.674$) neutral priming trials.

Similarly baseline adjusted grip strength levels did not significantly change after 5 ($t(23) = 0.198$, $p = 0.845$), 10 ($t(23) = 0.043$, $p = 0.966$), 15 ($t(23) = 0.186$, $p = 0.258$) or 20 ($t(23) = 0.384$, $p = 0.561$) neutral priming trials for those higher self-perceptions. See Figure 5.5.

6.4 Discussion

The aim of study 4 was two-fold. 1) I aimed to advance previous research by examining whether the effects of age-stereotypes upon older adults' functional health, as measured by grip strength (a key biomarker of successful aging), would be differently affected based on older adults' levels of self-perceptions of age. 2) From a methodological perspective I also aimed to advance previous research by determining (if implicit age-stereotype word primes did have a differential effect upon grip strength based on older adults' self-perceptions of age) the extent to which these implicit form of age-stereotype word primes operate in a cumulative manner to affect grip strength.

Study 4 shows that after controlling for education level, all older adults were affected by the age-stereotype word primes; both those with lower and higher self-perceptions of age experienced reduced grip strength following the negative age-stereotype word primes, and increased grip strength following the positive age-stereotype word prime conditions, and finally grip strength did not significantly change following the neutral age-stereotype prime for all participants.

In support of the first aim, results demonstrated that individual differences, specifically older adults' self-perceptions of age, do allow for differential effects of age-stereotypes upon measures of functional health. For instance, results showed that the pattern of change in grip strength across the age-stereotype word prime conditions varied amongst the two groups of older adults; after controlling for education levels, those with lower self-perceptions of age experienced a greater decline in grip strength following the negative age-stereotype word prime condition, in comparison to those

with higher self-perceptions of age. Following the positive age-stereotype word prime condition, those with lower self-perceptions of age also experienced a smaller increase in grip strength in comparison to those with higher self-perceptions of age.

This is the first study to examine the effects of subliminal age-stereotype primes using different subgroups of older adults, based on individual differences in self-perceptions of age. It is also the first to test whether these individual differences in self-perceptions of age render some older adults more of less vulnerable to the effects of both positive and negative age-stereotypes across trials

The current findings are, however, consistent with previous age-stereotype threat research that has demonstrated that some individual differences do mediate the effects of age-stereotypes upon older adults functioning. For instance, previously Andreoletti et al. (2004) have shown that within older adults, age-stereotype effect varied by education levels. For those older adults who reported 4 years or less of education, exposure to negative age-stereotypes resulted in significantly poorer memory recall performance compared to those with higher education levels. The current results are also consistent with more recent similar findings showing that older adults with lower education levels were more likely to recall false information during a memory task after exposure to negative age-stereotypes in comparison to those older adults with higher education levels.

These findings have important implications for future intervention programmes. Knowledge about which individual differences can contribute to stereotype sensitivity is useful for identifying those most at risk of age-stereotype effects in real world scenarios. The current findings show that older adults who report poorer self-perceptions of age are most vulnerable to the detrimental effects of negative age-stereotypes. In real life scenarios, this vulnerability to negative age-stereotypes may create a vicious cycle of decline in functional health, i.e., exposure to negative age-stereotypes can decrease

measures of functional health, such as grip strength, which could lead to even further poorer self-perceptions of ageing, leaving older adults with increased vulnerability to the effects of negative age-stereotypes.

As mentioned above, the current study is also the first to examine the accumulative effects of implicit age-stereotype word primes across trials. The current study's results highlight that in support of the second aim, those with lower self-perceptions of age not only experience a steeper decline in baseline adjusted grip strength, but importantly also require exposure to a fewer number of implicit negative age-stereotype word primes to reduce baseline adjusted grip strength in comparison to those with higher self-perceptions of age (i.e., they are vulnerable to the effects of negative age-stereotypes). Conversely, when those with lower self-perceptions of age were exposed to positive age-stereotype word primes, not only did they experience smaller improvements to baseline adjusted grip strength, but importantly they also require exposure to more positive implicit age-stereotype word primes to improve baseline adjusted grip strength in comparison to those with higher self-perceptions of age.

These findings are consistent with previous research (Hehman et al., 2013) which shows that exposure to implicit negative age-stereotypes can have a cumulative effect upon older adults' memory performance. Hehman et al. (2013) showed that, during a memory task, not only did exposure to negative age-stereotype threat result in reduced memory performance but results also demonstrated that the more stereotype threat experienced, the poorer the performance on the memory task became.

More importantly though, findings are also consistent with previous research examining how stereotypes and social information is processed (Wigboldus, Dijksterhuis, & Van Knippenburg, 2000). Their results showed that people prefer to maintain their existing beliefs (e.g., poorer perceptions of ageing) rather than change

them. When processing social information (such as age-stereotypical word primes) individuals show a preference to focus encoding processes upon information which acts as evidence in favour of one's existing beliefs. Put more generally, people encode social information in a stereotype-maintaining way.

In the current study, those with poorer self-perceptions of age may have focused their encoding processes more upon the negative age-stereotype word primes because these were more consistent with their already existing poor perceptions of their own ageing experience thus allowing them to experience a larger decrease in grip strength, and also requiring exposure to fewer of the negative age-stereotype word primes to cause this decline in baseline adjusted grip strength (in comparison to those with higher self-perceptions of age).

While it may be helpful for individuals to focus encoding processes upon on social information which fits with their existing beliefs, it also allows the individual to avoid obtaining counterevidence, and therefore makes stereotypical views (such as poorer self-perceptions of age) more resistant to change as they keep reinforcing themselves (Dijksterhuis & van Knippenberg, 2000). With this in mind, this would also explain why the converse pattern of results was found for those with poorer self-perceptions during the positive age-stereotype priming condition, where those with lower self-perceptions of age experience smaller improvements to baseline adjusted grip strength, and also require exposure to more positive age-stereotype prime words to improve baseline adjusted grip strength. As this positive priming information is not consistent with their existing poorer self-perceptions of age, the positive age-stereotype word primes may not have been as readily encoded, resulting in smaller improvements in grip strength (from baseline), in comparison to those who hold positive self-perceptions of age, who would focus information processes on encoding the positive

age-stereotype information that is consistent with their existing positive beliefs about ageing.

Taken together, the results of the current study overall highlight that in comparison to those with higher self-perceptions of age, those who report lower self-perceptions of age appear to be more vulnerable to the adverse effects of age-stereotype prime words and require exposure to fewer negative age-stereotype prime words in order to significantly reduce grip strength. In what seems like a cruel twist of fate, whilst those with low self-perceptions of age appear to be most affected by the negative age-stereotype prime words, they also seem to gain the least benefit from the positive age-stereotype word primes (or require more exposure to gain benefits from exposure to positive age-stereotypes).

Much of the age-stereotype priming research highlights that positive age-stereotype interventions can significantly increase functional health measures for older adults. These results demonstrate however that this approach to improving older adults' functional health may not be quite so straightforward. Individual differences are at play in the effects of age-stereotypes and unfortunately those older adults who report poorer self-perceptions of age appear to experience smaller improvements to functional health (as measured by grip strength) as a result of positive age-stereotypes, but also will require exposure to more positive age-stereotype primes in comparison to those with more positive self-perceptions of age. Further implications of the current findings will be discussed in the General Discussion (Chapter 6).

6.4.1 Conclusions

Study 4 has shown that after controlling for education level, older adults with lower self-perceptions of ageing are more vulnerable to the effects of negative age-stereotypes and as such experience larger declines (from baseline) in grip strength following exposure to negative age-stereotypes, in comparison to older adults with

higher self-perceptions of age. Similarly, those with lower self-perceptions of age also seem to gain less benefit from the positive age-stereotype word primes, as improvements in grip strength following the positive age-stereotype prime condition were significantly smaller for those with lower self-perception of age in comparison to those with higher self-perceptions of age. It also appears that whilst those with poorer self-perceptions of age require exposure to fewer negative age-stereotypes to reduce baseline grip strength, they also require exposure to more positive age-stereotype word primes to improve baseline adjusted grip strength in comparison to those with higher self-perceptions of age. It is possible that this is because individuals show a preference to process stereotypical information that is consistent with their existing beliefs (Wigboldus et al., 2000) and therefore those with lower self-perceptions of age would allocate more encoding processes upon the negative age-stereotype word primes.

Chapter 7: General Discussion

7.1 Introduction

This final chapter will provide a full discussion of the research findings and implications of the thesis. Firstly, I will summarise the key findings from each empirical chapter (chapters 3-6). Secondly, I will consider the theoretical implications of the findings presented. Thirdly, I will consider application of the findings; highlighting the implications of this thesis for (a) local government policy, (b) media and advertising governing bodies, (c) for health professionals (d) and for individuals themselves.

7.1.1 Summary of key findings from each empirical chapter

7.1.1.1 Chapter 3: Study 1: The Relationship between Self-Perceptions of Age and Grip Strength in Younger and Older Adults.

Study 1 aimed for the first time to determine whether there is a naturally occurring relationship between self-perceptions of age and a reliable marker of health (Ling et al., 2010; Rantanen et al., 2000), namely grip strength, within a sample of healthy younger adults and a sample of healthy older adults. My second aim was to expand previous research by examining the relationship between self-perceptions of age and grip strength using a UK based sample of younger and older adults. This was because previous research was limited in that it exclusively focussed upon North American samples, despite the varying trends in physical health across nations (North & Fisk, 2015). My findings revealed that firstly, younger adults' self-perceptions of age scores did not correlate with grip strength levels during an everyday-based reaching and grasping task. In contrast, and in support of the hypothesis, within the older adults only, self-perceptions of age were positively correlated with peak grip strength during the same reaching and grasping task. Moreover, a partial correlation determined that this relationship even remained significant after controlling for increasing age within the

older group. This is the first study to demonstrate a naturally occurring relationship between self-perceptions of age and this key measure of functional health (grip strength) in a UK based sample of older participants. These findings are consistent with a plethora of studies which demonstrate a positive relationship between older adults' self-perceptions of age and self-report measures of functional health in North American older adults. For instance, older adults with more negative self-perceptions subjectively rated their health as poorer (Jang et al., 2004), take poorer care of their health, and consider seeking medical help for reversible age-related changes as less important compared to older adults with more positive self-perceptions of age (Sarkisian et al., 2002). Study 1 advanced previous research which had predominantly relied on self-report measures of functional health, by demonstrating that self-perceptions of age were also related to performance-based measures of functional health; as measured by grip strength, which is considered to be a key bio-marker that is widely accepted as a measure of how successful an individual is ageing.

This finding arguably adds to the literature that suggests individual differences in older adults' self-perceptions of age is linked to changes in the levels of functional health they experience. It therefore is possible that not all older adults' health status is equally susceptible to the subjective influences of internally or externally induced perceptions of ageing (e.g., age-stereotypes). These findings were the basis of subsequent studies in this thesis which aimed to determine whether both self-perceptions of age and grip strength would be affected by exposure to subliminal age-stereotyped information (i.e., culturally valid age-stereotyped word primes). This would determine whether age-stereotyped word primes can alter self-perceptions of age amongst older adults and to test whether they also show better functional health, illustrated by grip strength performance on the same hand grip task.

In summary, I found a naturally occurring correlational relationship between older adults' self-perceptions of age and a key measure of functional health (grip strength). The next experimental chapter aimed to test whether both self-perceptions of age and grip strength could be manipulated by implicitly primed age-stereotyped words (study 3).

7.1.1.2 Chapter 4: Study 2: The Development of an Implicit Age-Stereotype Word Priming Paradigm.

As mentioned above, I wanted to experimentally test the effects of implicit (subliminal) age-stereotypes upon both self-perceptions of age and grip strength. In order to achieve this goal, I first needed to create a task which could do this. Study 2 aimed to create a bespoke method that could implicitly present age-stereotype word primes. Over a two-stage process, I developed a method of implicitly priming participants with age-stereotypes, which improved upon three commonly cited methodological limitations of previous research. I: 1) incorporate UK-generated and culturally relevant positive and negative age-stereotype prime words; 2) included a neutral word priming condition, consisting of neutrally valanced words which were also generated by UK participants; 3) tailored the presentation duration of subliminal word priming stimuli to each participant's own individual visual processing speed (i.e., presented the stimuli for a duration quicker than they could consciously detect it / was below their level of conscious awareness).

Stage 1 of study 2 created 10 UK culturally relevant positive, negative and neutral age-stereotype priming words that would be the basis of age-stereotype manipulations in the subsequent studies 3a, 3b, and 4. The positive ageing words included: *independent; wise; active; alert; mobile; knowledgeable; insightful; adaptable; accomplished; engaged*. The negative ageing prime consisted of 10 negative age-stereotype prime words: *slow; senile; decrepit; frail; forgetful; dependent; immobile; impaired; weak; disabled.* The neutral age-stereotype word prime included:

impartial; usual; normal; standard; everyday; regular; average; representative; mainstream; neutral.

Stage 2 of study 2 developed a 2-step computer-based priming task. Step 1 identified the optimal presentation speed for the age-stereotype word primes for each individual participant by presenting 10 non-words, beginning with either an 'a' or 'l' on a PC screen, using a descending limits paradigm with the stimuli presentation durations corresponding to gradually slowing visual processing speeds (51ms, 85ms, 119ms, 153ms, 187ms, 221ms). Step 2 of the priming procedure used the individually tailored priming method to then test the effects of the primes on grip strength.

Consistent with previous research (Levy, 2000; Stein et al., 2002), during step 1, checks on manipulations analysed response times and accuracy during the task. Participant's ratings of stimuli visibility, response times and accuracy during the task were measured. Results demonstrated that participants response times and accuracy of responses were not significantly different between conditions when the stimuli were presented at speeds where the stimuli were rated as 'clearly visible' or 'not visible at all' (i.e., when the stimuli was presented for a duration quicker than they could consciously detect it).

Taken together, these results indicate that even during presentation speeds in which participants reported being unable to visibly perceive any of the non-word primes, participants were still able to respond in an appropriate time and were no less accurate in choosing the correct corresponding key (which matched the content of the non-prime word) compared to when they could consciously detect the primes.

Ultimately these results demonstrate that priming paradigm had been successful in presenting word priming content to the participants below their level of conscious awareness (i.e., presenting the stimuli for durations tailored to their visual processing speed) as even though participants could not report seeing any content of the non-word

primes, they still successfully encoded the content of the non-word prime in order to correctly respond.

In summary, study 2 created a bespoke method that could implicitly present age-stereotyped word primes. This two-stepped task improved upon three commonly cited methodological limitations of previous research. It: 1) incorporated UK-generated and culturally relevant positive and negative age-stereotype prime words; 2) it included a neutral word priming condition, consisting of neutrally valanced words which were also generated by UK participants; 3) the two-step task tailored the presentation duration of subliminal word priming stimuli to each participants own individual visual processing speed (i.e., presented the stimuli for a duration quicker than they could consciously detect it). I then used this two-step task in the following study (study 3) to examine the effects of implicitly primed age-stereotyped words on both self-perceptions of age and grip strength.

7.1.1.3 Chapter 5: Study 3: The Effects of Age-Stereotyped Prime Words on Self-Perceptions of Age, and Grip Strength during a Precision Grasping Task.

Study 1 of the current thesis demonstrated a natural association between self-perceptions of age and grip strength (after controlling for age) and was found only within the sample of older adults. Study 2 subsequently developed a bespoke priming task that can be used to implicitly prime participants with UK culturally based age-stereotyped prime words. This bespoke priming paradigm has been specifically developed to overcome regularly cited limitations in previous age-stereotype priming research. The current study now aimed to use this bespoke age-stereotype priming task that was developed in study 2, to investigate whether the natural association between grip strength and self-perceptions of ageing in older adults (found in study 1) is affected by subliminal exposure to culturally valid age-stereotyped word primes. More specifically, I aimed to examine whether subliminal exposure to age-stereotyped word primes could alter (a) self-perceptions of age and (b) grip strength.

Results showed, as predicted, that within the older adults only, positive age-stereotyped word primes significantly increased, whilst negative age-stereotyped word primes significantly reduced both self-perceptions of age and grip strength, and that the effects on grip strength were mediated by the impact of the age-stereotyped stimuli on self-perceptions of age. Also, as expected, the neutral word primes elicited no change in either self-perceptions of age, or grip strength. These results are consistent with similar patterns of results found in previous research testing the effects of age-stereotypes on basic measures of physical functioning (Levy et al., 2014). A novel finding of the current study revealed that for the first time, older adults' self-perceptions of age mediate the effects of age-stereotyped word primes on grip strength. These results support the argument that age-stereotypes can affect older adults' physical functioning by acting as an intervention which either strengthens or weakens older adults' self-perceptions of their own ageing (according to positive or negative age-stereotype prime content, respectively), which in turn acts as an intervention to strengthen or weaken physical function (Levy et al., 2014). One upshot of this finding is that it may suggest those older adults who report more positive self-perceptions of age may be less vulnerable to the adverse effects of popular negative age-stereotypes. Unfortunately, by the same token, these results may also mean that those older adults who report negative self-perceptions of age may be susceptible to the adverse effects of negative age-stereotypes. I investigated this concept further in the following study by investigating whether individual differences left some older adults more vulnerable to the effects of age-stereotypes.

7.1.1.4 Chapter 6: Study 4: Do age-stereotype word primes effect older adults differently as a function of self-perceptions of age and are these effects cumulative?

The findings of the previous 3 chapters show, in turn, that older adults' self-perceptions of age successfully predict grip strength, that implicit age-stereotype word

primes can successfully manipulate both older adults' self-perceptions of age and grip strength, and that age-stereotype word primes increase or decrease older adults' self-perceptions of age (dependent on the valence of the age-stereotype prime) which in turn then acts as an intervention to either increase or decrease grip strength.

As study 3 shows that the effects of age stereotyped word primes are a function of self-perceptions of ageing, the current study aimed to explore whether individual differences in self-perceptions of age affect vulnerability to the priming effects. Knowledge about which individual differences contribute to stereotype sensitivity may be useful for identifying those most at risk of age-stereotype effects in real world scenarios.

The aim of study 4 was to investigate whether there are individual differences in susceptibility to the effects of age-stereotyped word primes on grip strength, and whether these effects operate in a cumulative manner across trials to affect grip strength.

Results demonstrated that individual differences in older adults' self-perceptions of age do allow for differential effects of age-stereotypes upon measures of functional health, i.e., grip strength. For instance, results showed that the pattern of change in grip strength across the age-stereotype word prime conditions differed between older adults according to their level of self-perceptions of age; after controlling for education levels, those with lower self-perceptions of age experienced a significantly greater decline in grip strength following the negative age-stereotype word prime condition, in comparison to those with higher self-perceptions of age. Following the positive age-stereotype word prime condition, those with lower self-perceptions of age also experienced a smaller increase in grip strength in comparison to those with higher self-perceptions of age. These findings are consistent with previous age-stereotype threat research examining the mediating role of education and age-stereotypes (Andreoletti et al., 2004) but more specifically, expand previous research by adding to the literature

that individual differences other than education levels (in this case, self-perceptions of age) are important in mediating the effects of age-stereotypes upon older adults' functional health, as measured by grip strength. These findings show that older adults who report poorer self-perceptions of age are most vulnerable to the detrimental effects of negative age-stereotypes. In real life scenarios, this vulnerability to negative age-stereotypes may create a downward spiral of decline in functional health. For example, exposure to negative age-stereotypes can decrease measures of functional health, such as grip strength, which could lead to even further poorer self-perceptions of ageing, leaving older adults with increased vulnerability to the effects of negative age-stereotypes.

Study 4 is the first study to examine whether there are individual differences in vulnerability to cumulative effects of implicit age-stereotype word primes across trials. The results demonstrated those older adults with lower self-perceptions of age not only experience a steeper decline in grip strength when exposed to negative age-stereotypes, but importantly also require exposure to a fewer number of implicit negative age-stereotype word primes to reduce grip strength, in comparison to those with higher self-perceptions of age. Conversely, when those with lower self-perceptions of age were exposed to positive age-stereotype word primes, not only did they experience smaller improvements to baseline adjusted grip strength, but importantly they also required exposure to more positive implicit age-stereotype word primes to improve baseline adjusted grip strength in comparison to those with higher self-perceptions of age. What is interesting about these results is that they highlight that those lower in self-perceptions of age are most vulnerable to the negative age-stereotypes yet are also least amenable to the improvements in grip strength from the positive age-stereotypes. Fortunately, those with lower self-perceptions of age do improve during positive age-stereotype priming, but these individual just require more exposure to the positive age-

stereotypes (i.e., require exposure to a higher number of positive age-stereotyped word primes).

This pattern of results is supported by previous research examining how stereotypes and social information is processed (Wigboldus, Dijksterhuis, & Van Knippenburg, 2000) that demonstrates when processing social information (such as age-stereotypical word primes) individuals show a preference to focus encoding processes upon information which acts as evidence in favour of one's existing beliefs. Put more generally, people encode social information in a stereotype-maintaining way.

It is likely that those with poorer self-perceptions of age may have focused their encoding processes more upon the negative age-stereotype word primes because these were more consistent with their already existing poor perceptions of their own ageing experience, thus allowing them to experience a larger decrease in grip strength, and also requiring exposure to fewer of the negative age-stereotype word primes to cause this decline in baseline adjusted grip strength (in comparison to those with higher self-perceptions of age). This would also explain why the pattern of results show that those with lower self-perceptions of age also seem to gain less benefit from the positive age-stereotype word primes; characterised by smaller improvements in grip strength following the positive age-stereotype prime condition and requiring exposure to more positive age-stereotype word primes to improve grip strength, in comparison to those with higher self-perceptions of age.

7.2 Overall Implications of Findings

7.2.1 Implications for theory and interventions

7.2.1.1 Implications for theory

A key theme in the findings of this thesis was that across all older adults, exposure to negative and positive age-stereotyped word primes both decreased and increased, respectively, all older adults' grip strength and self-perceptions of age. Study

3 further demonstrated a novel finding that in fact older adults' self-perceptions of their own ageing experience mediate this effect of age-stereotypes. Study 4 replicated consistent findings in a new sample of healthy older adults; highlighting that across all, participant's experienced significant decreases and increases in grip strength following either negative or positive age-stereotype word priming. These findings support previous research which links age-stereotypes to reduced functioning on other more basic measures of functional health (e.g., time taken to rise from seated position) or walking speeds (e.g., swing time). These findings also extend our current understanding of the effects of age-stereotypes as I have demonstrated that both negative and positive age-stereotypes can also influence relevant kinematic measures of functional health, such as grip strength. Grip strength is required to perform an array of daily living tasks (Simard et al., 2012). Grip strength is also considered to be a key marker of successful ageing, which predicts nursing home admission, and health related outcomes such as disability (Rantanen, Volpato, Ferrucci, Heikkinen, Fried, & Guralnik, 2003) and mortality (Volaklis, Halle, & Meisinger. 2015). The current findings that such a key measure of functional health can be manipulated by age-stereotype word priming highlights the potential that relatively simple interventions could have. For example, interventions that promote positive self-perceptions of age, such as the Generations Working Together programmes (McKay, *Olds Cool Intergenerational Project,* 2018) could improve self-perceptions of age, and in turn act as an intervention to help maintain grip strength and promote physical fitness in older age. The subjective age literature (e.g., Stephan, Kotter-Grühn, & Jaconelli, 2013; Stephan & Terracciano, 2015) supports the assertation that how old or young an individual feels is an important marker of development, with a growing interest directed at the potential benefits of a youthful subjective age for wellbeing and health-related outcomes in older age.

Moreover, recent research demonstrates that manipulations to older adult's subjective age, so that they felt younger, resulted in increased grip strength (Stephan et al., 2013).

Study 4 of the current thesis has highlighted for the first time that individual differences do influence the effect of age-stereotypes; demonstrating that in comparison to those with positive self-perceptions of age, the functional health of older adults with poorer self-perceptions of age experienced a greater reduction in grip strength following negative age-stereotype word primes, but also demonstrated smaller improvements in grip strength following the positive age-stereotype word primes. This also has important theoretical implications. From a theoretical perspective this has furthered our understanding of age-stereotypes in three ways. 1) This is the first research to attempt to identify which older adults may be most at risk of experiencing the adverse effects of negative age-stereotyping. The ability to identify older adults most at risk to experience the effects of negative age-stereotypes is useful for both researchers and clinicians alike, so that interventions can be directed towards those who are most in need of access to ageing interventions which promote functional health.

2) This pattern of results is also particularly interesting from a theoretical perspective as it supports social and stereotypical information processing literature (Wigboldus et al, 2000) which proposes that individuals show a preference to focus encoding processes upon information that acts as evidence in favour of one's existing beliefs. Consistent with these findings, it is likely that those with poorer self-perceptions of age focused their encoding processes more upon the negative age-stereotype word primes because these were more consistent with their already existing poor perceptions of their own ageing experience, thus, allowing them to experience a larger decrease in grip strength, and also requiring exposure to fewer of the negative age-stereotype word primes to cause this decline in grip strength. Whilst it may be helpful for individuals to focus encoding processes upon on social information which fits with their existing

beliefs, it also allows the individual to avoid obtaining counterevidence, and therefore makes stereotypical views (such as poorer self-perceptions of age) much more resistant to change as they keep reinforcing themselves (Dijksterhuis & van Knippenberg, 2000).

3) From a theoretical perspective these findings would also provide one possible explanation for why some researchers within the age-stereotype literature have been able to report initial age-stereotype priming effects, but subsequently fail to replicate these findings in future studies with new participant samples (i.e., while result patterns follow the expected trends, they do not reach statistical significance). For instance, Horton et al (2008) who initially reported that negative age-stereotypes significantly reduced performance on a range of abilities but then in subsequent studies (Horton et al., 2010) whilst he was able to show that negative age-stereotypes did reduce recall performance, walking speed and flexibility, this reduction did not reach statistical significance. Whilst these two studies both aimed to recruit healthy older adults, they recruited from a popular retirement area within Canada (Ontario) with a larger than average older adult population (Horton et al., 2010) which may contribute to the general perception that life as an older adult is generally positive. Applying the current finding that those with negative self-perceptions are most affected by negative age-stereotypes, it is possible that those new participants recruited from Ontario are likely to have more positive self-perceptions of age and so subsequently would be less effected by the negative ageing stereotypes and would also require exposure to a greater number of negative age-stereotypes to cause similar reductions in performance. This would account for why Horton et al (2010), along with other researchers (Moriello et al., 2013) findings did not reach statistical significance.

Finally, beyond theoretical implications, the findings of study 4 have also highlighted practical implications for researchers regarding future age-stereotype priming research. The fact that my research has shown older adults with poorer self-

perceptions of age to experience the largest decrease in grip strength following negative primes, but also subsequently experience the smallest improvement in grip strength following positive age-stereotype priming suggests that simple age-stereotype interventions are unlikely to have the same blanket effect for every single participant. It is likely that individual differences will moderate the impact that the age-stereotype priming intervention has upon the individual. For instance, those with more positive self-perceptions of age will likely respond to such positive age-stereotype interventions favourably, however, for those with lower self-perceptions of age these interventions are less likely to be immediately effective. Priming interventions therefore should adapt for the role of these individual differences and focus on identifying those with poorer self-perceptions of age, exposing these individuals to an increased number of positive age-stereotypes in order to reverse the effects of culturally embedded negative age-stereotypes.

7.2.1.2 Implications for society and public policy

On a societal level as a whole, my overall thesis findings highlight the need for tighter UK government policies which limit the media's ability to negatively stereotype the ageing process. At present, as the UK has very few policies which curtail the media's ability to paint a negatively stereotyped image of older age, and as such, negative perceptions of the ageing process are formed from as young as 6-years old (Burke, 1981). For instance, due to a lack of policy regulations, children's books often characterise older adults with descriptions or images which depict older adults as incapable, forgetful, mentally rigid, and as sleeping all day (Arluke & Levin, 1982; Cohen, 2000). Unfortunately, these negative perceptions of the ageing process are ingrained throughout the life span, with advertising and media outlets (e.g. TV adverts and birthday cards [Picket, 2002]) further characterising the ageing process as wholly negative (Lee, Carpenter & Meyers, 2007). Recent statistics show that TV adverts reinforce stereotypes of older adults as being overly concerned with declining physical

functions and financial/legal vulnerability; missing any portrayal of the positive aspects of ageing and so does not reflect the wide range of varying experiences people have with ageing (Lee et al, 2007). Unsurprisingly, when younger adults and older adults find themselves aging, the expectations they have developed from a lifetime of watching TV (as well as other media sources) are somewhat more negative and misrepresentative of the mosaic pattern of changes which incorporates both declines and improvement in inabilities as we age (Light, 1991).

My findings demonstrate that instead, our government should either put in place new policies that are similar to those which have reduced other forms of discrimination, such as racism or sexism, or extend these existing policies to also include ageism. These policies should challenge the media's use of negative ageist language, and to instead replace the stereotyping of older adults as 'frail' and 'dependent' with positive stereotypes and language, which accurately reflect the role and diversity of the older adult population. The use of more positive language and positive stereotypes would more accurately recognise the contribution that older adults make both in social terms, but also in economic terms as workers, volunteers and often carers (Care UK, 2014).

If these policies were in place, this would help to eradicate the misrepresentation of older adults in children's books (Burke, 1981), and educational settings, which would start to re-shape the perceptions that future generations have of older adults, hopefully, creating a more positive perception of the ageing process from as young as 6-years old (Burke, 1981). Policies which regulated not only the language that books, and birthday cards used to represent older age, but also regulations which controlled how TV content represents older adults (e.g., the roles they are cast for) could promote positive age-stereotypes which accurately reflect the wide variation in abilities with age, but also the positive societal and economic contribution of older adults.

These policy changes that encourage media sources to promote more positive stereotypes which accurately reflect the wide individual variation of ageing, would mean that adults would enter older age with more positive perceptions of age, which as this thesis has shown, would allow them to experience increased functional health (i.e., grip strength), and would also protect them from the adverse effects of negative age-stereotypes. Ultimately, this would increase older adults' ability to remain functionally healthy and living independently at home for longer. This is becoming increasingly important as the number of older adults living for longer continues to increase (Office for National Statistics, 2018), placing an increased strain on health and social care services.

These changes in policy would also help the local Scottish Government (SG) achieve their agendas on reshaping care for older people as these clearly highlight a need for older adults to remain functionally independent at home, for longer. The current thesis required participants to perform a grasping task which asked participants to lift an object using their thumb and index finger; this particular grasping motion is known as a precision grasp. Motor control literature has shown this particular grasping action to experience the most severe age-related changes in comparison to other hand grasping motions (Carmel, Patish, & Coleman, 2003). The ability to perform this action successfully is essential to be able to perform many everyday tasks, such as writing with a pen, correctly holding cutlery to eat, and the ability to hold a glass to drink from (Carmel, et al., 2003). Therefore, consistent with the current thesis findings, it is possible that if we increased older adults' positive self-perceptions of age, in turn, they would experience an increased ability to successfully perform these daily living tasks and live independently at home for longer.

The overall findings of the current thesis also highlight a need for further training of medical professionals. The psycho-social effects of age-stereotypes on

functional health should be included in medical training for new healthcare staff, but also in professional development for existing healthcare staff. This training should emphasise the adverse effects that negative ageist language can have on older adult's functional health. For example, using language that has negative connotations about ageing is likely to act as a negative age-stereotype prime, and reduce older adults' functional health. More importantly though, this re-training should also educate staff on how they may already existing negative perceptions of the ageing process, paying focus on how these negative perceptions of the ageing process can often influence the medical attention older adults receive from healthcare workers. For instance, doctors may rely on these existing negative perceptions of ageing when making decisions as to whether to administer aggressive medical treatments to older adults, rather than basing this decision exclusively on whether or not the older adult is healthy or strong enough to cope with the treatment.

7.2.1.3 Implications for Interventions

Knowledge about which individual differences that can contribute to stereotype sensitivity is useful for identifying those most at risk of age-stereotype effects in real world scenarios. The current thesis has shown (study 4) that older adults who report poorer self-perceptions of age are most vulnerable to the detrimental effects of negative age-stereotypes. In real life scenarios, this vulnerability to negative age-stereotypes may create a downward spiral of decline in functional health. Exposure to negative age-stereotypes can decrease measures of functional health, such as grip strength, which could lead to even further poorer self-perceptions of ageing, leaving older adults with increased vulnerability to the effects of negative age-stereotypes. A key aim within the Scottish Government's 'Reshaping Care for Older People 2011-2021' agenda is to embed educational materials relating to declines in physical function declines into workforce training and development for those health and social care professionals working with older adults, to help them identify those most at risk of decline. With this

in mind, the current findings that those with poorer self-perceptions of age are more at risk of experiencing declines in functional health as a result of exposure to negative age-stereotypes, could not only help health and social care professionals to identify those most at risk of experiencing declines in functional health, but more crucially these professionals could support at risk older adults further to reduce the impact that negative age-stereotypes could have upon their functional health. One way in particular to achieve this would be for those community based social care professionals to share this knowledge and information about how ageing self-stereotypes may be influencing older adults' abilities. Providing older adults with education on how ageing self-stereotypes can both increase and decrease cognitive and physical abilities would offer the prospect of self-awareness. This would allow older adults to recognise when ageing stereotypes are likely to operate in daily living and how to recognise that these stereotypes may be adopted and accepted by themselves unwittingly.

7.3 Limitations and recommendations for future research

It has not been within the scope of the current thesis to experimentally investigate whether changes to functional health from either the negative or the positive age-stereotype prime words are longitudinal. The effects of the age-stereotype word primes upon grip strength levels within the current thesis lasted for the duration of the testing session; approximately 1 hour. One limitation or criticism of age prime research is that primes are often considered to be of momentary or short-term impact, and that currently little is known about the long-term effects of age stereotype primes. Very recent research using a very similar age-stereotype word priming paradigm (Levy et al., 2014) has demonstrated that basic measures of physical functioning, such as the time taken to rise from a seated position, can be improved by exposure to positive age-stereotype word primes. These improvements lasted approximately 3 weeks post exposure. However, the current study did not include the longitudinal effects of

negative age-stereotype primes. Results from study 4 demonstrated that those with lower self-perceptions of ageing experienced significant declines in grip strength immediately following the negative primes. However, those with higher self-perceptions of age required exposure to more negative primes (i.e., across trials) to significantly reduce grip strength. It is possible that the effects of negative age primes could be frequent and discrete, rather than one long lasting effect. Previous research shows that older adults consider themselves to be portrayed as frail or incompetent in television shows, adverts and greetings cards; these are just but a few of the ways in which older adults report experiencing age-stereotypes (Picket, 2002) on numerous occasions throughout the day in daily life. The results (Study 4) which shows that to some extent age-stereotypes operate in a cumulative manner, applying these to daily living situations, it is also logical to consider that many short exposures to negative ageing primes throughout daily living could restrict and limit older adults' (especially those with lower self-perceptions of age) functional health. Further research investigating the longitudinal effects of both negative and positive age-stereotypes is required.

A second limitation is that there may be practical difficulties associated with using an implicit age-stereotype word priming intervention (such as the one used in the current thesis) in attempt to improve older people's functional health outside of laboratory settings. For instance, it is a rather time-consuming process to measure each individual's visual processing speed, and to further select the correct presentation duration for the implicit age-stereotype word prime does require a specific skill set. All of this must be done correctly to ensure that the age-stereotype word primes are presented below participants' levels of consciousness but still allowing the content of the age-stereotype word primes to be encoded. With this in mind, future research could consider whether other techniques that are easier to implement in community settings to

implicitly prime older adults with positive age-stereotypes could also result in improvement to self-perceptions of age and therefore also improve their functional health measures. Social psychology research has investigated ways of changing racist and sexist attitudes, as well as other forms of in-group and out-group behaviour (Aronson and Bridgeman, 1979; Greenfield, Davis, Suzuki, and Boutakidis, 2002; Jackson et al., 2002). This literature has identified some important principles that may have relevance to dealing with ageism and internalised age-stereotypes. Future research which aims to connect the two literatures might lead to more effective means of combating negative age-stereotypes within older adults and thus increasing positive self-perceptions of age, leading to more positive outcomes in functional health. For instance, work on challenging automatic biases may prove to a useful format for community-based interventions aiming to reduce negative age-stereotypes. Dasgupta and Greenwald (2001) have been successful in changing negative age-stereotypes about older adults by using exemplars who are associated with fewer automatic biases. Such research may also in turn benefit current psychological knowledge and theory about preventing and remediating age-based discrimination because of the ways that age discrimination may vary from other forms of discrimination.

7.4 Conclusions

This is the first psychological research to find a robust link between older adults' self-perceptions of their own ageing experience and grip strength (a reliable marker of functional health in older age). The findings reported in this thesis have highlighted the negative impact that culturally imbedded negative age-stereotypes can have upon older adults' functional health (as measured by grip strength), but also highlighted the value and usefulness of positive age-stereotypes in improving functional health within health older adults. The evidence presented in this thesis supports and adds to the current literature examining the link between age-stereotype priming and physical functioning

in older age (e.g., Levy et al., 2000; Blanchard-Fields et al., 2002; Horton et al., 2008; Horton et al., 2010; & Levy et al, 2014).

Ultimately 4 key messages emerge from this PhD thesis. Firstly, older adults' self-perceptions of age are related to functional health (as measured by grip strength) in older age and could be used to identify those who are most in need of support to remain functionally active.

Secondly, exposure to negative age-stereotypes increases older adults' negative self-perceptions of age and subsequently reduces their grip strength. Positive age-stereotype priming on the other hand increases positive self-perceptions of age, which acts as a positive intervention and in turn, increases grip strength.

Thirdly, older adults who report poorer self-perceptions of age are more vulnerable to the adverse effects of negative age-stereotypes upon functional health; experiencing larger declines in grip strength in comparison to those who report more positive self-perceptions of age. In contrast, whilst those with lower self-perceptions of age do experience significant improvements in grip strength following positive age-stereotype priming, these improvements are smaller than those experienced by older adults with more positive self-perceptions of age.

Finally, those who do report poorer self-perceptions of age experience an immediate decline in grip strength when exposed to negative age-stereotypes; requiring exposure to only 5 negative age-stereotype prime words, in comparison to those with more positive self-perceptions of age, who required exposure to 10 negative age-stereotype word primes. Of particular importance for future interventions, those individuals with lower self-perceptions of age also required exposure to more positive primes (15) in order to significantly increase grip strength, whilst those with more positive self-perceptions of age experienced immediate improvements in grip strength following exposure to as little as 5 positive age-stereotype words.

The current PhD thesis is not attempting to deny that moderate decline in functional health is inevitable with advancing age, however it does highlight the important role that psychosocial factors, such as age-stereotypes and self-perceptions of age, can play in making such decline more manageable and supporting older adults to remain functionally independent. Interventions can be useful tools improving measures of functional health in older adults (e.g., grip strength), however, both researchers and practitioners alike should take account of individual differences such as self-perceptions of age, when designing / implementing positive age-stereotype interventions to improve measures of functional health.

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Chapter 8**: Appendix**

8.1 Appendix 1: Health Questionnaire

Participant ID Number ……

1) Do you currently have any chronic medical conditions of which you are currently prescribed medication?

……
…….....

2) Have you been diagnosed with any neurological health conditions? If so, please identify these below (e.g. Parkinson's).

……
…… …….....

3) Can you please provide us with a list of prescribed medications you are currently taking on a regular basis?

……
…….....

4) Do you have any form of arthritis? If so, can you please indicate where you experience this?

……
…… ……

5) Have you been diagnosed with any eyesight problems? (e.g., Macular degenerative disorder).

……
…… ……

6) Can you please provide us with your postcode? This is purely for research purposes and will not be shared.

……
…… ……

8.2 Appendix 2: Philadelphia Geriatric Centre Morale Scale.

Items were rated on a 5-point scale (ranging from 1- strongly disagree to 5- strongly agree (higher scores indicate greater satisfaction with their own ageing experience).

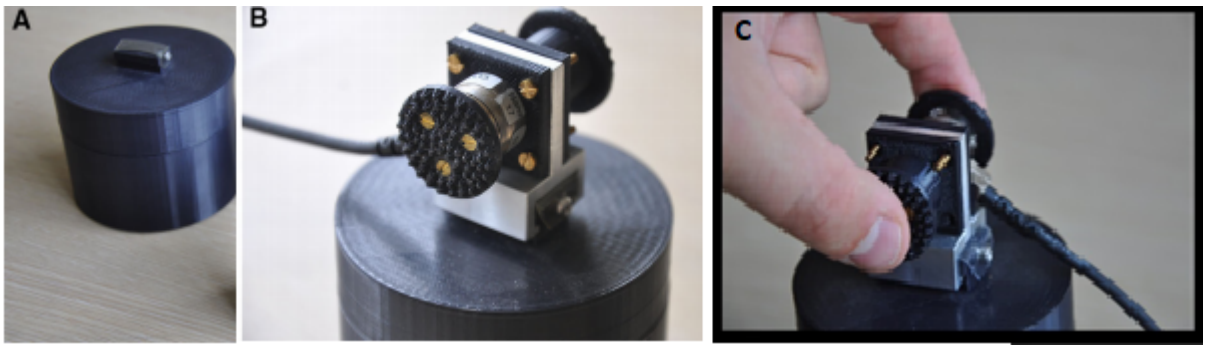
1. Do things keep getting worse as you get older? Yes/No Rating: ……
2. Do you have as much pep as you had last year? Yes/No Rating: ……
3. Do you feel that as you get older you are less useful? Yes/No Rating: ……
4. As you get older, are things better/worse than you thought? Better/worse. Rating: ……
5. Are you as happy now as you were when you were younger? Rating: ……

8.3 Appendix 2: Supplementary information regarding the hand grip task.

Picture A shows the object that older adults were asked to lift. This cylindrical object weighed around 200g, which is the average weight of a cup of liquid, such as tea. The object has a plastic mount on the top, this allows for a quick and easy attachment / detachment of the force transducer (used to measure grip strength when lifting the object).

Picture B is a close-up shot of the grip force transducer. This shows 2 round pads on either end with slight textures on them. These are the parts which record grip strength levels into the computer.

Picture C shows an example of the precision grasping task that participants were asked to perform. As you can see, participants were asked to use their thumb and index finger when attempting to lift the object off the desk.



8.4 Appendix 3: Full description of how the age-stereotype word primes were developed.

1. 10 individuals (aged 15, 21, 21, 37, 43, 59, 60, 70, 82, 84 years) were asked to generate three lists of adjectives: one "characteristic of healthy ageing" (positive age primes); one "characteristic of ageing poorly" (negative age primes), and one neutral (neither positive nor negative in valence) and not specific to ageing. **Participants were asked to generate as many words as possible for each list. Participants generated between 8 and 21 words, in around 5 to 15 minutes per list. All participants produced some words that were the same as those generated by other participants. All of the words generated are listed below.**

Positive adjectives generated: *independent, wise, active, alert, mobile, knowledgeable, insightful, adaptable, accomplished, engaged*,* elder, senior, mature, developing, discovering, engaged, experienced, enlightened, clever, intelligent, energetic, educated, informed, able, sharp, quick, uninhibited, outspoken, optimistic, positive, kind, friendly, warm, respectful, polite, well-mannered, understanding, accepting, reassuring, calming, thoughtful, generous, forgiving, tolerant, compassionate.

*The words in italics were those which met the criteria described below.

Negative adjectives generated: *slow, senile, decrepit, frail, forgetful, dependent, immobile, impaired, weak, disabled*,* aged, ancient, mumbling, elderly, waning, drooling, grey, tired, fatigued, mature, knackered, weary, inactive, infirm, miserly, *geriatric*, doddery, crusty, useless, stumbling, toothless, hunched, redundant, *senile*, wrinkled, shrivelled, fousty, lonely, declining, deaf, dispensable, fussy, eccentric, isolated, separate, ignored, distracted, obsolete, agitated, confused, grumpy, *sedentary*,

burden, feebleminded, haggard, crooked, vulnerable, unstable, imbalanced, miserable, blind.

*The words in italics were those which met the criteria described below.

Neutral adjectives generated: *impartial, usual, normal, standard, everyday, regular, average, representative, mainstream, neutral**, fair, plain, middling, midpoint, ambiguous, central, indifferent, dispassionate, common, *unbiased*, objective, stationary, equal, ordinary.

*The words in italics were those which met the criteria described below.

2. Then a new group of 10 people (aged 15, 21, 23, 35, 47, 55, 60, 63, 74, 83 years) rated the positive and negative adjectives on two dimensions: how characteristic of healthy/poor older age they seemed on a scale of 0 (very uncharacteristic) to 10 (very characteristic); and how positive or negative the adjectives seemed on a scale of 0 (extremely negative) to 10 (extremely positive). For the neutral adjectives, these 10 participants rated how specific each of these was to ageing on a scale of 0 (specific to ageing) to 10 (unrelated to ageing), and in terms of their valence on a scale from 0 (extremely negative) to 10 (extremely positive).

3. The positive adjectives that were selected as primes met the following criteria among all raters: (a) all adjectives were judged to be characteristic of healthy older age (7 or more out of 10); (b) the positive adjectives were rated 7 or above (out of 10) on the negative/positive valence scale. **Words that did not meet these criteria were rejected**. **Ten UK positive age-related primes met these criteria: independent, wise, active, alert, mobile, knowledgeable, insightful, adaptable, accomplished, engaged.**

[N.B Compare this to positive list from the American version from the 90's, which used a similar priming procedure, and had 12 rather than 10 adjectives; the Scottish v American list only overlaps on 4 of the words: guidance, **wise, alert**, sage, **accomplished**, learned, improving, advise, creative, enlightened, **insightful,** astute.]

The negative adjectives that were selected as primes met the following criteria among all raters: (a) all adjectives were judged to be characteristic of poor older age (7 or more out of 10); (b) the negative adjectives were rated 3 or below (out of 10) on the negative/positive valence scale. **Words that did not meet these criteria were rejected. Thirteen UK negative age-related primes met these criteria. The aim was to use the same number of negative, positive, and neutral primes in each experimental condition (10), thus three of the negative words were removed (geriatric, senile, sedentary), based on the criterion that these were the three words (out of the thirteen that met the criteria) that were generated the least number of times across the 10 participants who generated the words.**

The final 10 UK negative age-related primes are: **slow, senile, decrepit, frail, forgetful, dependent, immobile, impaired, weak, disabled.**

[N.B The negative list from America also overlaps on only 4 of the words: alzheimer's, decline, **dependent**, **senile**, misplaces, dementia, dying, **forgets**, confused, **decrepit**, incompetent, diseased.]

This second group of 10 participants also rated the neutral adjectives on two dimensions: how unrelated to ageing they seemed on a scale of 0 (highly related to ageing) to 10 (highly unrelated to ageing); and how positive or negative the adjectives seemed on a scale of 0 (extremely negative) to 10 (extremely positive). The neutral adjectives selected for the control condition were those that were rated **by all raters** as

(a) **unrelated** to ageing (7 or above) and (b) neutral on the valence scale (between 4-6 out of 10). **Words that did not meet these criteria were removed. Eleven neutral primes met these criteria, with one removed (*unbiased*) to produce 10 neutral primes, based on the criterion that this word (out of the 11 that met the criteria) was generated the least number of times across all participants who generated the words.** The final age-unrelated, neutral adjectives are**: impartial, usual, normal, standard, everyday, regular, average, representative, mainstream, neutral.**